THE BULLETIN

a monthly publication of the
AMERICAN CERAMIC SOCIETY
devoted to the promotion of ceramic art and technological education

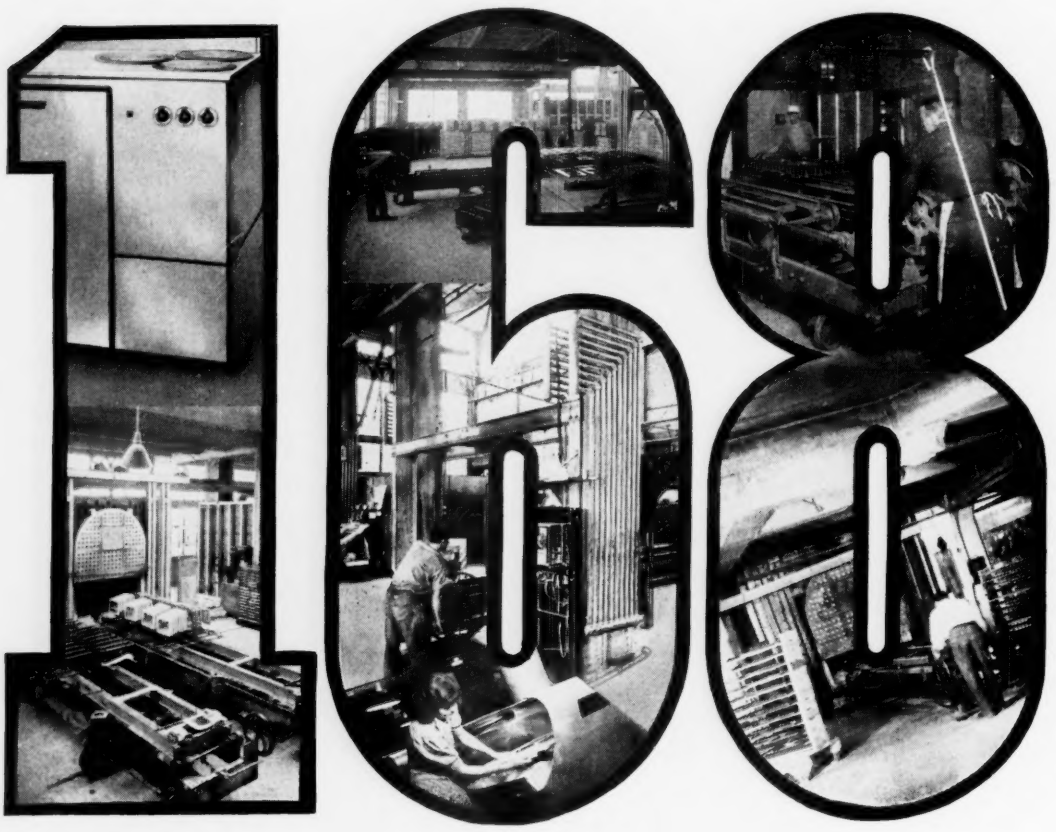
37TH

Annual Meeting Program of the American Ceramic Society

February 17 to 22, 1935
Hotel Statler, Buffalo, N. Y.

Volume 14 FEBRUARY, 1935 Number 2

WHY one hundred and sixty-eight



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THE BULLETIN

of the

AMERICAN CERAMIC SOCIETY

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Potassium Bichromate
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THE BULLETIN

of the American Ceramic Society

A Monthly Publication Devoted to Proceedings
of the Society and Promotion of Coöperative Research
of Technical, Scientific, and Art Questions

Vol. 14 February, 1935 No. 2

PROGRAM OUTLINE FOR THE THIRTY-SEVENTH ANNUAL MEETING OF THE AMERICAN CERAMIC SOCIETY

February 17–22, 1935, Buffalo, N. Y.

All meetings will be held at the Hotel Statler.

Admission to technical sessions and manufacturing establishments will be by Official Badge and Student Courtesy Card only.

Tickets for social events will be provided for all who register.

Registration Fee, $5.00

The Registration Fee will be $5.00 for all persons (members and nonmembers attending technical sessions and making plant visits).

Ladies (nonmembers) accompanying members of the Society, who wish to attend only the social affairs planned for them, will be exempt from the Registration Fee.

Luncheon Charges

The Hotel Statler charge for group luncheons will be $1.00 per person.

Meeting Rooms All Week

Local Committee and Service...Parlor B and Room 481
Ladies' Headquarters.....Library
Editorial and Press Room.....Parlor A
Officers and Committees.....Parlors B and C

NOTICE

Members of the Society and guests are requested to leave their Railroad Certificates at the Registration Desk for validation. Be sure that each one is *signed legibly*, so as to insure rapid handling.

Sunday, February 17, 1935

Registration: All Day

Forenoon and Afternoon

10:00 A.M.

Board of Trustees.....Fillmore Room

2:30 P.M.

Division Officers and Committees.....Parlor E

5:30 P.M.

Publications and Editorial Committees Dinner-Meeting.....Parlor F

Evening

8:00 P.M.

President's Reception.....Terrace Room

9:00 P.M.

Concert: The Carborundum Company Band.....Terrace Room

Monday, February 18, 1935

9:30 A.M.

General Session
Symposium on Ceramic Ware Firing.....Chinese Room

2:00 P.M.

General Session
Ceramic Art Program.....Georgian Room

4:00 P.M.

Fellow Meeting.....Parlor D

6:30 P.M.

Ceramic School Alumni Dinner-Meetings.....Rooms to be assigned

9:00 P.M.

Buffalo Shuffle.....Ball Room

Program Outline (*continued*)

Tuesday and Wednesday, February 19 and 20, 1935

9:30 A.M. and 2:00 A.M.

Division Meetings

Art.....Parlor D
Enamel.....Fillmore Room and Parlor E
Glass.....Georgian Room
Refractories.....Chinese Room
Structural Clay Products and Terra Cotta.....Parlor F
White Wares.....Iroquois Room and Parlor G

NOTE: The National Brick Manufacturers Research Foundation will meet on Wednesday Morning in the Iroquois Room.

Tuesday, February 19, 1935

12:00 M.

General Luncheon Committee Reports.....Ball Room

6:00 P.M.

Keramos Dinner

6:00 P.M.

Local Section Officers Dinner-Meeting

7:00 P.M.

Committee C-8, A.S.T.M.....Fillmore Room

8:00 P.M.

(1) Edward Orton, Jr., Fellow Lecture

By Dr. H. Ries, Cornell University, Cornell, N. Y.....Ball Room

Some Aspects of Clay Research

(2) Induction of Fellows

By President W. Keith McAfee

(3) Presentation of Charles Fergus Binns Medal to Frederick H. Rhead

By Dean M. E. Holmes

(4) Memorial Services for Charter Members

Charles Fergus Binns 1857–1934
William Day Gates 1852–1935

Eulogy by Willard D. Richardson, Columbus, Ohio

Wednesday, February 20, 1935

12:00 M.

Refractories Division Luncheon.....Ball Room
Speaker: E. A. Harding, E. I. du Pont de Nemours & Co., Inc., Niagara Falls, N. Y.
Subject: Liquid Air

6:30 P.M.

Student Reception and Dinner (Hosts are the Student Branch of the New York State College of Ceramics) Georgian Room

7:30 P.M.

Abstracters' Meeting.....Parlor E

9:30 P.M.

Dance and Floor Show.....Main Dining Room

Thursday, February 21, 1934

9:00 A.M.

Enamel Division.....Fillmore Room and Parlor E
Refractories Division.....Chinese Room

Morning

Choice of trip to

(1) Bethlehem Steel Company Open-Hearth Plant at Lackawanna
(2) Chevrolet Motor Company and Buffalo Pottery Company

Afternoon

Choice of trip to

(1) Niagara Falls sight seeing
(2) Niagara Plant Trip: Huntley (steam) Power Plant, Carborundum Furnace Room, Niagara Wall Paper Co., Niagara (hydraulic) Power Co.

Evening

6:30 P.M.

Dinner.....Hotel Niagara

Return on Canadian side, viewing the Falls illuminated, returning to Buffalo via the Peace Bridge.

Friday, February 22, 1935

Choice of trip to

(1) Corning Glass Works, Corning, N. Y.
(2) General Electric Company and Hammermill Paper Company, Erie, Pa.
(3) Bausch & Lomb Optical Company and Eastman Kodak Company, Rochester, N. Y.

GENERAL SESSION

SYMPOSIUM ON CERAMIC WARE FIRING

Under the Auspices of the Materials and Equipment Division

***Chairman*, R. C. Meeker, Kentucky-Tennessee Clay Co., Alliance, Ohio**

***Secretary*, H. B. Du Bois, Consolidated Feldspar Corp., East Liverpool, Ohio**

***Program Chairman*, George H. Brown, Dept. of Ceramic Engineering, Rutgers Univ., New Brunswick, N. J.**

Monday Forenoon, February 18, 1935

9:30 A.M.–12:30 P.M.

Chinese Room

1. The Physics and Chemistry of the Firing Process

By J. B. Austin, Research Lab., United States Steel Corp., Kearny, N. J.

A review of the objectives of the firing process interpreted in terms of the basic chemical reactions occurring during the firing of ceramic ware and of the fundamental laws of heat flow applicable to such a process is presented.

2. The Basic Requirements of the Firing Process (General Discussion)

By J. A. Doyle, W. S. Rockwell Co., 50 Church St., New York, N. Y.

More thought in terms of uniform ware and of action of heat on the surface is essential in the determination of better methods of heating and cooling to improve quality, and better methods of utilizing heat and handling ware to reduce cost are needed.

Uniform exposure to permit uniform transfer of heat to or from the surface is as essential as uniform temperature.

Uneven circulation or radiation accounts for much variation in uniformity of product not disclosed by the pyrometer.

Physical characteristics of the individual piece, or charge of many pieces, should govern the rate of heating or cooling.

No one form of fuel or electricity has a monopoly on efficiency in the firing process.

3. Effects of Combustion Methods on the Temperature Uniformity of Kilns and Furnaces

By F. O. Suffron, American Gas Assn. Testing Laboratory, Cleveland, Ohio

The results of several years research in the fundamentals of gas combustion under the auspices of the Industrial Gas Research Committee of the American Gas Association are related to the practical application of gas combustion principles in kiln firing. The factors influencing heat transfer from the products of combustion to the ware are discussed as well as the effect of design, type of combustion, and secondary aëration on the uniformity of heat distribution and atmospheric control.

4. The Control of Atmosphere and Its Effect on Ware.

By Matt Mawhinney, Salem Engineering Co., Salem, Ohio

5. Some Uses of the Electric Furnace for Ceramic Firing

By E. J. Harris, The Carborundum Co., Niagara Falls, N. Y., and Ben A. Bovee, Globar Corp., Niagara Falls, N. Y.

The paper covers the design and operation of small periodic electric furnaces, discussing heating and cooling cycles and control, both electric and thermal. Types of ware being fired and the kiln furniture used are described. The cost of operation is shown, based on prevailing electrical power rates, including figures on energy consumption per pound of ware fired.

6. The Efficiency of Kilns

By F. A. Whitaker, General Ceramics Co., Keasbey, N. J.

A definition of the efficiency of industrial furnaces with special reference to kilns is presented. The difference between efficiency and effectiveness is brought out and a comparison is made of periodic and continuous kilns and the minimum requirements of the latter with a review of the sources of heat losses.

7. Draft-Pressure Factor in Heat Distribution

By Ellis Lovejoy, Columbus, Ohio

See this issue, p. 93.

GENERAL SESSION

A Series of Papers under the Auspices of the Art Division

***Chairman*, L. E. Barringer, General Electric Co., Schenectady, N. Y.**

Monday Afternoon, February 18, 1935

2:00 P.M.–4:00 P.M.

Georgian Room

1. International Standardization of Colors

By A. Maerz, American Color Research Laboratory, Ridgewood, N. J.

Colors may be referred to by names or by systematic symbols. Of the latter, a number of systems have been proposed during the course of years, but none has ever found general or lasting acceptance. The reasons for this are brought out in a concise outline of the development of such systems and in an analysis and comparison of the whole group. A history of this kind has never been drawn up before, and without it as a background the standardization of colors and of a decent nomenclature can not be understood. The custom of referring to colors by names is examined in detail to determine whether a more systematic and standardized usage of names is not possible. The commercial usage and requirements in the ceramic and other industries are looked into toward this end. The possibilities of a universal standard nomenclature are examined, and details of an organization for international action made public.

2. Commercial Importance of Design in Ceramic Ware for Utilitarian Purposes

By Margaret George, Director of Allied Art and Industry, Buffalo Fine Arts Academy—Albright Art Gallery, Buffalo, N. Y.

The author discusses the following questions: What is design? What is commercial importance? Are they inevitably related? Who is qualified to realize that relationship? The artist or the manufacturer or both? By sporadic and occasional association or by sustained cooperation?

3. Increased Sales through Design and Marketing Tests

By O. M. Forkert, Director, Design and Layout Dept., The Cuneo Press, Chicago, Ill.

The author will discuss the following topics: (1) What are the most practical and objective points a good design should be able to answer to increase sales? (2) What are the tests that can be applied to the ceramic business or any other industry of today? (3) How to take the expenditures for design, advertising, and marketing out of the realm of guess work.

4. A Photocolor Process for the Decoration of Ceramic Ware

By T. S. Curtis, Industrial Research Laboratories, Huntington Park, Calif.

Original water colors, wash drawings, paintings, textiles, or living objects may be reproduced with photographic fidelity and in full color rendering in vitrifiable colors on ceramic ware by this process. The methods of making the original color photograph through the use of special absorption filters which translate the tones of the original into the available primary ceramic printing colors will be described. The process of printing directly upon the glazed surface of wall tile, obviating the use of decalcomania transfer, will also be disclosed. The process offers interesting possibilities for the low-cost decoration of tile with virtually unlimited scope in artistic effect, since the technique of the original artist is faithfully reproduced in large quantity production.

ART DIVISION PROGRAM

***Chairman*, L. E. Barringer, General Electric Co., Schenectady, N. Y.**
***Secretary*, Charles Harder, New York State College of Ceramics, Alfred, N. Y.**
***Papers and Program Committee:* Arthur E. Baggs, Ceramic Art Dept., Ohio State University, Columbus, Ohio, and H. S. Nash, University of Cincinnati, Cincinnati, Ohio**

Tuesday Forenoon, February 19, 1935

9:30 A.M.–12:30 P.M.

Parlor D

1. Downdraft Woodburning Kiln for Local Red Clays

By Edgar H. Strong, N. Y. State College of Ceramics, Alfred, N. Y.

A description is given of an inexpensive wood-fired kiln suitable for school and camp pottery projects.

2. Raw Leadless Glazes for Pottery and Tile at Cone 2

By C. W. Merritt, N. Y. State College of Ceramics, Alfred, N. Y.

A base glaze was developed using colemanite as the principal flux. A series of colors was produced by blending ten glazes containing different coloring materials.

3. Red Glazes and Underglaze Red by Reduction

By Charles M. Harder, N. Y. State College of Ceramics, Alfred, N. Y.

A firing procedure is formulated along the lines laid down by Seger for the production of copper red glazes and underglaze red. Possible methods of control of the liver red, cherry red, and purple red *flambé* glazes are given.

4. Contribution of Ceramics to the Blue-Greens in the Color Scale

By Richard Grant, 1309 Michigan Ave., Cincinnati, Ohio

The blue-green section of the color circle has lately been found to have greater importance than formerly appreciated, as it occupies a larger section of the color circle in its true relation than formerly assigned to it, and it is complementary to the color section red to golden-yellow.

Ceramic material furnishes the most durable colors of any of the crafts for the blue-green section, and a close study of this section should be made by ceramic technicians. The various factors which help or hinder the hue, clarity, and intensity of the color depend on the nature and color of the ground and the character and manner of application of the glaze. (Editor's note: The author regrets that he can not be present to defend his paper as it has a very close relation to the proposed question of color nomenclature. He feels that the nomenclature of color will not be permanent until the colors are properly connected to their true position in the color circle. Reference is made to Wilhelm Ostwald's book on The Science of Color (see *Ceram. Abs.*, **13** [11], 282 (1934)).

5. Notes on the Use of Ceramic Products in Landscape Design

By Henry F. Kenney, 1342 Parkridge Pl., Cincinnati, Ohio

While ceramic materials have been used in gardens and other landscape development from earliest times, apparently little has been written on the subject except in an incidental way. It is hoped that this paper will stimulate interest not only in past achievements along this line, but also will encourage the production of materials that will enhance the beauty, interest, and utility of landscape areas and stimulate the production of a greater range of fine ceramic ware for out-of-door use.

6. The Future of Decorative Porcelain Enamel

By H. Edward Winter, Ferro Enamel Corp., Cleveland, Ohio

A short résumé is given of the history of art enameling, some contemporary enamelers of Europe, and its recent use in this country. The author's recent works, showing the development of transparent and opaque glazes for copper as to their use for home furnishings and decorations, are discussed. A set of thirty colored lantern slides will give examples of these as well as the twenty porcelain-on-steel murals executed recently for commercial use.

Tuesday Afternoon, February 19, 1935

2:00 P. M.–5:30 P.M.

Parlor D

7. Ceramic Art in the Public Schools: Reasons and Methods

By Charles M. Harder, N. Y. State College of Ceramics, Alfred, N. Y.

A primer of ceramic processes for those engaged in teaching in schools, camps, and institutions.
(To be read by title.)

8. New York Suggests to a Member of the American Ceramic Society

By Ruth Canfield, Friendship, N. Y.

9. Modern Ceramics and the Museum

By William M. Milliken, Cleveland Museum of Art, Cleveland, Ohio

The ceramic art of past centuries finds its place inevitably in every great museum of art. The museum, if it is to keep its hold on life, must not neglect the significant in the ceramic productions of our own time.

10. Sources of Illustrative Material for Ceramic Art Education

By Mrs. Noah Feldman, 201 E. 18th St., Brooklyn, N. Y.

11. Future of the Art Division (General Discussion)

Led by Lawrence E. Barringer, General Electric Co., Schenectady, N. Y.

ENAMEL DIVISION PROGRAM

***Chairman*, W. N. Harrison, National Bureau of Standards, Washington, D. C.**
***Secretary*, B. J. Sweo, National Bureau of Standards, Washington, D. C.**
***Chairman, Papers and Program*, R. R. Danielson, Metal & Thermit Corp., Carteret, N. J.**

Tuesday Forenoon, February 19, 1935

9:30 A.M.–12:30 P.M.

Fillmore Room and Parlor E

Applied Research Program

1. Current Work on Enamels at the National Bureau of Standards

By W. N. Harrison, National Bureau of Standards, Washington, D. C.

Some results of an investigation of strains in enamels, the method of expressing thermal expansion characteristics, and a brief discussion of new investigations are presented.

2. Mechanics of Enamel Suspension, II. The Electrodialysis of Some Enamels and Glasses

By R. M. King, Ohio State University, Columbus, Ohio

The technique of electrodialysis has been applied to enamels and glasses with a view to studying the general effect of this treatment and to correlating the results obtained with the acid resistance of enamels and glasses. Some data have also been obtained which suggest the use of this method as a test for the durability of glass.

3. Effect of Mill Additions and the Blending of Frits on the Expansion of Ground Coats for Sheet Steel

By R. L. Fellows and E. E. Howe, Chicago Vitreous Enamel Products Co., Cicero, Ill.

The effect of clay, feldspar, and silica when introduced at the mill in a two-frit ground coat, as measured by the interferometer method, is discussed.

4. A Discussion Relating to the Thermal Expansion Method from Theoretical and Practical Standpoints

By C. J. Kinzie and C. H. Commons, Jr., Titanium Alloy Mfg. Co., Niagara Falls, New York.

Calculated factors are compared with coefficients as determined by the interferometer and by the rod methods, and conclusions are drawn relating to the probable effect upon results obtained.

5. A Method and Apparatus for Studying the Physical Properties of Vitreous Enamels on Steel

By J. E. Rosenberg and A. Langerman, O. Hommel Company, Pittsburgh, Pa.

A method has been devised for studying the physical properties of the fused enamel containing the mill additions by firing it onto a split-steel ring and studying the changes in the radius of the ring and stresses produced due to the difference in the coefficient of thermal expansion of the enamel and the steel. This gives a means of studying not only the coefficient of expansion but the modulus of the elasticity and the "freezing point" of the enamel.

6. Relation between Cobalt and Nickel Oxide Content and Reboiling of Sheet Steel Ground-Coat Enamels

By J. M. Cayford and R. M. King, Ohio State University, Columbus, Ohio

Since cobalt- and nickel oxide-bearing enamels are the only ones known to reboil in this study, some relationships between the amount of these oxides present and the duration of reboiling are shown.

7. Enamel Plant Operation and Control

By E. C. Aydelott and W. H. Pfeiffer, Frigidaire Corp., Dayton, Ohio

Methods of operation and control in the manufacture of porcelain enameled refrigerator parts and linings are discussed.

8. Mechanics of Enamel Adherence, XI. Application of the Theory of Dendritic Adherence to the Development of White Ground Coats for Sheet Steel

By W. L. Housley, Canton, Ohio, and R. M. King, Ohio State University, Columbus, Ohio

Some white oxides have been found which give a dendritic formation when incorporated in enamels which are applied directly to steel. An X-ray study of these formations has been made.

9. Further Data on Enamel Adherence

By Karl Kautz, Republic Steel Corp., Massillon, Ohio

The results of ground-coat enameling of iron and various metals in air, nitrogen, and *in vacuo* are given. Microphotographs of the bond developed between ground-coat enamels and various metals and their oxides are also shown.

Enamel Division Program (*continued*)

Tuesday Afternoon, February 19, 1935

2:00 P.M.–5:00 P.M.

Applied Research Program (*continued*)

Fillmore Room and Parlor E

10. An Adherence (or Adhesion) Test for Determining the Adherence of Ground Coats to Metal

By C. J. Kinzie and J. B. Miller, Titanium Alloy Mfg. Co., Niagara Falls, N. Y.

The machine is described in detail and results are discussed.

11. A Comparison of the Results of Different Machines for Measuring Reflectivity

By Gordon L. Bryant and F. R. Porter, Edison General Electric Appliance Co., Chicago, Ill.

The reflectivity of a set of six standard white porcelain enameled panels of various enamel thicknesses was measured by six different types of reflectivity apparatus used for the purpose. A brief description of each apparatus and also the comparative measurements are given.

12. Opacity Development in Cover Enamels for Sheet Steel

By James D. Tetrick, Metal & Thermit Corp., Carteret, N. J.

A study was made of opacity development in cover enamels for sheet steel, with the relation to firing time, firing temperature, gage of base metal, and opacifying elements used.

13. Color Stability in Enamels

By William J. Baldwin, O. Hommel Fellowship, Mellon Institute, Pittsburgh, Pa.

Enamel frits with varying sodium oxide and boric oxide content were tested with various colored oxides and the stability of the color was noted. Frits in which the boric oxide is slightly in excess of sodium oxide gave the best results with reds, mahogany, etc.

14. Some Experiments in the Development of a Sand Abrasion Machine

By G. H. Spencer-Strong, Porcelain Enamel & Mfg. Co., Baltimore, Md.

The apparatus is described and data are given to show its adaptability for the resistance of porcelain enamels to abrasion.

15. Report of Committee on Standards of Tests

By Dwight G. Bennett (Chairman), Mellon Institute, Pittsburgh, Pa.

A discussion of methods now in use and those being developed for testing physical properties of enamels, including resistance to abrasion, impact, and flexure, is presented.

16. Report of Research Committee

By R. M. King (Chairman), Dept. of Ceramic Engineering, Ohio State University, Columbus, Ohio

The present status of enamel research is reviewed.

17. Report of Committee on Data

By E. P. Poste (Chairman), Consulting Chemical Engineer, Chattanooga, Tenn.

A review of the 1934 literature on vitreous enamels is presented.

18. Report of Committee on Standards of Chemical Analyses

By Robert Schaal (Chairman), Roberts & Mander Stove Co., Hatboro, Pa.

Results of survey of methods of analyses for enamel raw materials used in various laboratories are reviewed.

Wednesday Forenoon, February 20, 1935

9:30 A.M.–12:30 P.M.

Fillmore Room and Parlor E

Shop Practice Program

19. Dry-Process Acid-Resisting Enamels for Cast Iron: a Compounding Study

By John Wassman and J. R. Sheppard, Eagle Picher Lead Co., Joplin, Mo.

A condensed account is given of the studies continued over a period of about a year on the compounding of acid-resisting enamels for cast iron. It involves a more or less systematic variation of the enamel formulas and the correlation of these results with certain of the properties which concern the user of enameled ware and the manufacturer, including resistance to acid, workability of fusion properties, color, and coefficient of expansion.

Enamel Division Program (*continued*)

(Wednesday Forenoon)

20. Laboratory Control in Dry-Process Enameling

By R. D. Cooke, Rundle Mfg. Co., Milwaukee, Wis.

A description is given of the methods used for controlling raw materials and mixing, melting, and applying dry-process enamels for cast-iron sanitary ware.

21. Observations of Defects in Cast-Iron Enameling

By G. H. Spencer-Strong, Porcelain Enamel & Mfg. Co., Baltimore, Md.

Dissolved oxide of iron in minute quantities causes blistering of cast-iron enamels. This iron oxide may be introduced from three sources, namely, pig iron, poor melting practice, or cheap oxidized scrap iron.

22. Notes on Draining Ground Coats for Sheet Steel

By Murray C. Gautsch, Baltimore Enamel & Novelty Co., Baltimore, Md.

Some observations on the effect of atmospheric conditions and other factors on the draining behavior of ground coats are given.

23. Temperature and Fineness Control of Ground Coats for Sheet Steel

By H. C. Beasley, Baltimore Enamel & Novelty Co., Baltimore, Md.

A discussion is presented of the importance of temperature and fineness control as an aid to proper draining of ground coats. Methods for temperature control of the milled enamel in storage and during application are given.

24. Some Physical Factors Affecting the Draining Properties of Ground-Coat Enamel

By W. N. Noble and G. S. Lindsey, Ferro Enamel Corp., Cleveland, Ohio

The temperature of milling of sheet-iron ground-coat slip, the amount of water used for milling, rapid cooling *vs.* slow cooling, and the temperature of the slip for draining are shown to affect draining qualities. No apparent differences occur from milling ground-coat frits separately and blending after milling compared with blending before milling.

25. Effect of Furnace Atmosphere on Enameling

By H. E. Ebright, G. H. McIntyre, and J. T. Irwin, Ferro Enamel Corp., Cleveland, Ohio

The factors affecting variations in furnace atmospheres and temperature gradients are discussed. Analytical methods and technique used in determining temperature gradients are given. Typical furnace-atmosphere compositions are reported together with their effects on enamel quality and production. Several specific cases of shop trouble, which would trace back to the firing furnace, with corrections applied, are discussed in detail.

26. Some Notes on the Application of Black Edging Enamel

By J. E. Rosenberg and A. Langerman, O. Hommel Co., Pittsburgh, Pa.

Some observations and experimental results in the application of black edging enamel are given.

Wednesday Afternoon, February 20, 1935

2:00 P.M.–5:00 P.M.

Shop Practice Program (*continued*)

Fillmore Room and Parlor E

27. The Use of Sodium Cyanide in a Neutralizing Bath in Pickling Sheet Iron for Enameling

By E. H. Shands, G. L. Bruten, and G. J. Grimes, Detroit Vapor Stove Co., Detroit, Mich.

Sodium cyanide has been found to be effective as an addition to the neutralizing bath, both from the standpoint of length of life of the solution and the ability of the sodium cyanide to dissolve iron and sodium salts.

28. The Use of Nickel Dip in Enameling Practice

By J. E. Hansen and J. T. Irwin, Ferro Enamel Corp., Cleveland, Ohio

A description of the composition of various nickel solutions now being used commercially, and reasons for their use are presented. Methods for control of p_H and an analysis of solutions are given.

29. Effect of Variations in Grinding on Fineness Distribution of Vitreous Enamels

By E. P. Poste, Consulting Chemical Engineer, Chattanooga, Tenn.

The results of an experimental study of the effects of variations in some of the conditions of grinding vitreous enamels on the distribution of particle size are given. These are followed by observations on the distribution of particle size in commercial batches of various enamels.

30. Effect of Clays on the Opacity of White Enamels for Sheet Steel

By R. R. Danielson, Metal & Thermit Corp., Carteret, N. J.

Some data are presented showing the effect of various types of clays used as mill additions on the opacity developed in white enamels for sheet steel.

Enamel Division Program (*continued*)

(Wednesday Afternoon)

31. Effect of Mill Practice and Mill Additions on Opacity of Enamels

By G. L. Bryant and F. R. Porter, Edison General Electric Appliance Co., Chicago, Ill.

Much work has been done in the past year or two by frit manufacturers to develop frits of ultra-opaqueness. This paper gives the results of work done to increase the opaqueness by mill practice and mill additions, such as milling to abnormal fineness, addition of opacifiers at the end of the milling period, the effect of the addition of feldspar, and the effect of different types of clays.

32. Shop Control of Colored Porcelain Enamels

By D. O. Koch, E. I. du Pont de Nemours & Co., R. & H. Chemical Div., Perth Amboy, N. J.

A discussion is presented on color manufacture and its control; how by careful standardization of milling, application, firing, and inspection, color variation in the shop can be minimized and matchings improved.

33. Observations on Some Enameling Difficulties

By F. G. Sutphen, American Rolling Mill Co., Middletown, Ohio

Some experiences in enameling plants with hairlining, copperheading, fishscaling, and blistering of enamels are given with methods found to be corrective.

34. A Frequent Cause of Pitting of Sheet-Iron Enamel

By P. C. Stufft, Porcelain Enamel & Mfg. Co., Baltimore, Md.

The contamination of either sheet-iron frit or milled liquid enamel by a very minute quantity of soft glass will cause pitting. This minute quantity has been determined to be as little as one part of soft frit in 100,000 parts of either frit or liquid enamel.

Thursday Forenoon, February 21, 1935

9:30 A.M–12:00 M.

Shop Practice Program (*continued*)

Fillmore Room and Parlor E

35. Relation between Thickness of Enamel and Chipping (Discussion)

Led by H. H. Holscher, Edison General Electric Appliance Co., Chicago, Ill.

An informal discussion is presented on the relation between chipping and thickness of enamel coatings.

36. One Cover Coat Enamel Finishes

By F. R. Porter and G. L. Bryant, Edison General Electric Appliance Co., Chicago, Ill.

The writers point out the attempt in recent years to reduce the thickness of enamel coatings in order to reduce chipping and material cost. A single cover-coat system of reduced thickness has been evolved and a brief summary is given of the necessary steps in this system.

37. Minimum Radius of Curvature for Enameled Parts

By H. H. Holscher, Edison General Electric Appliance Co., Chicago, Ill.

A comparison of burning off and chipping of porcelain enamel over bent edges of various outside radii shows that $^{9}/_{64}$ inch is the minimum radius to which the iron should be bent.

38. Some Questions in Regard to Design of Porcelain Enameled Products (Discussion)

By B T. Sweely, Cicero, Ill.

A discussion is presented on the correct design of structural units, refrigerators, stove parts, and other ware to be coated with porcelain enamel.

39. Enamel Practice in Finland

By Risto Jarnefelt, Helsingfors, Finland

The author, who is superintendent of an enameling plant in Helsingfors, Finland, will describe enameling practice in Finland and compare it with American practice.

40. Report of Special Committee on Survey among Manufacturing Members as to whether Standardization of Products Is a Proper Function of the Enamel Division

By Frank Hodek (Chairman), General Porcelain Enamel Co., Chicago, Ill.

41. Report of Committee on Nominations

By Murray C. Gautsch (Chairman), Baltimore Enamel & Novelty Co., Baltimore, Md.

42. Installation of Officers

Supplementary Title

43. A Progress Report of the Study of the Thermal Reactions in Enamels during Smelting

By A. I. Andrews and C. M. Andrews, Dept. of Ceramic Engineering, Univ. of Illinois, Urbana, Ill.

GLASS DIVISION PROGRAM

***Chairman*, James Bailey, Bailey & Sharp, Inc., Hamburg, N. Y.**
***Secretary*, F. C. Flint, Hazel-Atlas Glass Co., Washington, Pa.**
***Chairman, Papers and Program*, U. E. Bowes, Owens-Illinois Glass Co., Alton, Ill.**

Tuesday Forenoon, February 19, 1935

9:30 A.M.–12:30 P.M.

Georgian Room

9:30–10:00 A.M.

1. The Calculation of Physical Properties of Glasses from Their Composition

By S. R. Scholes, Department of Glass Technology, New York State College of Ceramics, Alfred, N. Y.

Calculation under additive theory is criticized. Factors should represent real values for substances on which they are based; this requires postulation of compounds, which is open to question. Specific volumes must be considered, since properties are an effect of volume, not of weight. Examples from data on B_2O_3 glasses are given.

10:00–10:30 A.M.

2. Viscosity and Thermal Conductivity of Soda-Potash-Silicate Glasses

By K. Lark-Horovitz and C. L. Babcock, Purdue University, Lafayette, Ind.

Using the method described previously (see *Jour. Amer. Ceram. Soc.*, **17** [11], 329–42 (1934)), the viscosity and electrical conductivity of glasses containing sodium, potassium, and silica have been investigated. It has been found that for all glasses containing an excess of potassium over sodium the simpler relation between conductivity λ and viscosity η,

$$\eta = A[1/\lambda]^B$$

does not hold any more. It has been found that in this case the temperature dependency of the work function for conductivity and viscosity is not the same, indicating the effect of the formation and breakup of complexes in this temperature.

10:30–11:00 A.M.

3. The Hardness of Glass

By G. W. Morey, Geophysical Laboratory, Washington, D. C.

A discussion of the significance of glass hardness and methods for its measurement are given.

11:00–11:30 A.M.

4. Changes in the Elastic Property of Glass as Affected by Temperature

By A. E. Badger and W. B. Silverman, University of Illinois, Urbana, Ill.

The modulus of elasticity of a soda-lime-magnesia-silica glass was determined at various temperatures up to 450°C by measurements of the elongation of a glass fiber under load. The modulus was found to decrease regularly with temperature rise except over the range 250 to 300°C, where a greater rate was noted.

11:30 A.M.–12:00 M.

5. Lithium Oxide as a Constituent of Glasses—Its Effect on Thermal Expansion

By Louis Navias, General Electric Co., Schenectady, N. Y.

Winkelmann and Schott give the factor of 10.0 to Na_2O, 9.5 to K_2O, and 2.0 to Li_2O to indicate the effect of these oxides upon thermal expansion. A review of the literature of glasses containing Li_2O and some measurements made on new glasses indicate that in respect to thermal expansion Li_2O is as effective as Na_2O and K_2O in promoting high expansibility.

12:00 M.–12:30 P.M.

6. Progress Report on the Development of Methods for the Determination of the Chemical Durability of Glass

By G. E. F. Lundell, National Bureau of Standards, Washington, D. C.

A large number of laboratories are coöperating with a Committee on Chemical Durability investigating a proposed method using samples of glasses issued by the National Bureau of Standards.

Tuesday Afternoon, February 19, 1935

2:00 P.M–4:30 P.M.

Georgian Room

2:00–2:30 P.M.

7. Relation of Electrical Surface Resistance of Glass to Chemical Durability

By E. M. Guyer, Corning Glass Works, Corning, N. Y.

Surface resistance measurements on a graded soda-lime-silica series of glasses and on a mixed series including borosilicates, lead glasses, lead borosilicates, and lime glasses are compared with measurements of loss of weight in water vapor made on the same glasses.

Glass Division Program (*continued*)

(Tuesday Afternoon)

2:30–3:00 P.M.

8. Some Observations on the Action of Steam on Glass

By O. G. Burch, Owens-Illinois Glass Co., Alton, Ill.

The action of saturated steam on glass is apparently an action of superheated water. Filtration of saturated steam with partial removal of entrained water materially decreases the rate of decomposition of glass in contact with the steam, while dry steam has no apparent effect on glass. The decomposition of blown glass articles by saturated steam is influenced by the size, shape, and thickness of the articles and by their past history.

3:00–3:30 P.M.

9. Investigations of Opalescent Glasses: Silicon, Sodium, Calcium, Aluminum, Oxygen, Fluorine Series

By Henry H. Blau and Victor Hicks, Macbeth-Evans Glass Co., Charleroi, Pa., and Alexander Silverman, Univ. of Pittsburgh, Pittsburgh, Pa.

This paper is an extension of the previous work of the authors to opalescent glasses containing aluminum. The melting losses for a series of glasses are reported and interpreted to throw new light on the liberation of fluorine from these glasses and the rôle of aluminum in them.

3:30–4:00 P.M.

10. The Contraction of Glass as Affected by Cooling Rates

By J. T. Littleton, Corning Glass Works, Corning, N. Y.

It has been known for some time that glass cooled from temperatures well above the annealing temperature contracts at a rate depending upon its cooling rate and the temperature from which its cooling begins. Expansion measurements taken on the glass during later heating do not follow the original contraction curve. A photoelastic method is described which gives information on how the contraction of the glass is affected by these temperature conditions. The observations are of particular interest when applied to glass-metal seals.

4:00–4:30 P.M.

11. The Measurement of Strains in Glass Rods

By A. W. Hull, General Electric Company, Schenectady, N. Y.

Mathematical analysis has shown that when a symmetrically strained glass rod is viewed in polarized light at right angles to its axis, the only phase displacements produced are those due to the axial components of stress. This method has been applied to the analysis of stresses in glass-metal seals. It is also applicable to the quantitative determination of annealing rates.

Wednesday Forenoon, February 20, 1935

9:30 A.M.–12:30 P.M.

Georgian Room

9:30–10:00 A.M.

12. X-Ray Diffraction Study of the Structure of Soda-Silica Glasses

By B. E. Warren, Massachusetts Institute of Technology, Cambridge, Mass.

X-ray diffraction patterns have been made on seven samples of soda-silica glass with soda varying from 0 to 46%. The change of pattern is perfectly continuous. The patterns can be quantitatively interpreted in terms of a random network structure. Each silicon is tetrahedrally surrounded by four oxygens. Part of the oxygens are bonded to two silicons and the others to one silicon and one or two sodiums. The patterns give no evidence for the existence of compounds.

10:00–10:30 A.M.

13. Infra-Red Transmission of Glass

By E. D. Tillyer and T. M. Gunn, American Optical Co., Southbridge, Mass.

Measurements of special glasses containing most of the usual elements, including transmission curves throughout the infra-red, are discussed.

10:30–11:00 A.M.

14. Strength of Glass under Sustained Loading

By F. W. Preston, Butler, Pa.

A preliminary report on the effect of the time element on the apparent strength of glass is given. Tests have been run on bottle glass from three seconds to 30 minutes duration and on polished plate and drawn window glass (in the form of laths) from five seconds to several hours.

11:00–11:30 A.M.

15. The Effect of Variable Viscosity upon Stress Release in Glass at a Constant Temperature

By H. R. Lillie, Corning Glass Works, Corning, N. Y.

An effort is made to demonstrate experimentally a relation between the rate of release of strain and the rate of change of viscosity for annealing at constant temperature. A new expression free from these objections and taking into account the variation of viscosity with time is shown correctly to represent observed annealing rates under a larger variety of conditions than those to which the Adams-Williamson law can be applied.

Glass Division Program (*continued*)

(Wednesday Forenoon)

11:30–11:45 A.M.

16. The Peate Telescope Mirror of 1895

By F. W. Preston, Butler, Pa.

The first big telescope mirror cast in the United States was made by the Standard Plate Company at Butler, Pa., in the spring of 1895 and was figured by John Peate, Greenville, Pa., between 1895 and 1898. A brief history of the undertaking is presented.

11:45 A.M.–12:00 M.

17. The History and Some Measurements of the Peate Disk

By George W. Morey, Geophysical Laboratory, Washington, D. C.

Through the courtesy of the Smithsonian Institution, opportunity has been given for making measurements on the Peake disk to ascertain the quality of the glass, of its annealing, and of its figure.

12:00 M.–12:30 P.M.

18. Some Engineering Problems Connected with the Manufacture of a 200-Inch Telescope Disk

By George V. McCauley, Corning Glass Works, Corning, N. Y.

The processes of melting, ladling, casting, annealing, and crating are explained from an engineering viewpoint. Departures from usual practice in these processes brought about by the use of existing equipment, a special glass, and commercially obtainable material are discussed. Illustrated.

Wednesday Afternoon, February 20, 1935

Joint Session with the Refractories Division

2:15 P.M.–4:40 P.M.

Chinese Room

REFRACTORIES DIVISION PROGRAM

***Chairman*, H. E. White, Lava Crucible Co. of Pittsburgh, Zelienople, Pa.**

***Secretary*, R. E. Birch, Harbison-Walker Refractories Co., Pittsburgh, Pa.**

***Papers and Program Committee:* H. M. Kraner, Corhart Refractories Co., Louisville, Ky.; K. E. Buck, Ross-Tacony Crucible Co., Philadelphia, Pa.; Nelson W. Taylor, Pennsylvania State College, State College, Pa.**

Tuesday Forenoon, February 19, 1935

9:30 A.M.–12:30 P.M.

Chinese Room

9:30–10:00 A.M.

1. Effect of Gas Pressure on the Behavior of Refractories

By S. M. Phelps and V. Cartwright, Mellon Institute, Pittsburgh, Pa.

There is very little information available on this subject, and because of its important bearing on furnace design and operation this study was made. The tests were conducted in a suitable furnace in such a way as to obtain the effect of the furnace-gas pressure when maintained at pressures of two inches above and two inches below atmospheric pressure. The duration of each test was 24 hours at 1600°C (2912°F). Temperature gradients within the wall are given, as well as photographs which show the effect of heat penetration.

The brick were subjected to the panel spalling test after having been preheated under the conditions mentioned.

These tests were made on two different types of clay refractories when "laid up" with kaolin joints and a "cold-set" cement, thereby bringing out the effect of the joint material.

10:00–10:30 A.M.

2. Forsterite and Other Magnesium Silicates as Refractories

By Raymond E. Birch and Fred A. Harvey, Harbison-Walker Refractories Co., Pittsburgh, Pa.

In a survey of magnesium silicates for use as refractories, experimental studies with talc, serpentine, and olivine, and also with mixtures of these minerals and magnesia are reported. Since forsterite ($2MgO \cdot SiO_2$) is the only magnesium silicate which has a stable existence above 1562°C, the development of a commercial magnesium silicate refractory required that the ultimate product should be mainly forsterite. Such a refractory was developed by enriching a low iron magnesium olivine with MgO. The magnesia served to convert the hydrous minerals found in the olivine (talc and serpentine) to forsterite. Talc and serpentine are so universally present in olivine that, in the absence of the magnesia treatment, they provide a low melting bond which would cause the refractory to fail at relatively low temperatures under load and to exhibit other unsatisfactory properties. On the other hand, the forsterite refractory showed only slight subsidence after 90 minutes at 1550°C under a load of 25 lb./sq. in. The general characteristics of the refractory are discussed. The data include refractoriness, hot and cold strength, volume stability when reheated, spalling, thermal expansion, chemical behavior, resistance to various slags, thermal conductivity, etc.

10:30–11:00 A.M.

3. Effect of Fused Alumina and Boron Oxide on Plastic Fire Clays

By D. G. Moore and R. K. Hursh, Dept. of Ceramic Engineering, University of Illinois, Urbana, Illinois

A by-product fused alumina grain and also B_2O_3 were added in small quantities to three plastic refractory bonding clays. With clays of low impurities, 2% B_2O_3 addition lowered thermal expansion, increased spalling resistance, decreased shrinkage, and improved refractoriness under load. No beneficial effects were noted in a highly impure clay.

Fifteen per cent fused alumina did not appreciably affect the thermal expansion of any of the three clays, but resistance to thermal shock was improved in a Tennessee ball clay and a northern Missouri plastic clay. All tests were made on bars, 4 by 1 by $^5/_8$ inch, dry-pressed at 2500 pounds per square inch, and fired at cone 14.

11:00–11:30 A.M.

4. Comparison of Used Silica Brick from Insulated and Uninsulated Basic Open-Hearth Roofs

By Fred A. Harvey, Harbison-Walker Refractories Co., Pittsburgh, Pa.

Samples of silica brick from the roofs of two basic open-hearth furnaces, one of which had been insulated and the other uninsulated, after a full campaign were compared chemically and petrographically. The uninsulated brick was divided into nine distinct color zones, while the insulated brick showed but three. The three zones of the insulated brick were nearly identical zone for zone with the three inner zones of the uninsulated brick. The zone of weakness which normally occurs in open-hearth roof brick from uninsulated furnaces did not occur in the brick from the insulated roof. Chemical and petrographic analyses are given.

11:30–12:00 M.

5. Young's Modulus of Elasticity at Several Temperatures for Some Refractories of Varying Silica Content

By R. A. Heindl and W. L. Pendergast, National Bureau of Standards, Washington, D. C.

Determinations of Young's modulus of elasticity on 10 brands of fireclay brick (ranging in silica content from 48 to 52%), 2 brands of silica brick, and an 80% alumina fire brick, were made at room temperature, 100, 200, 400, 500, 600, and 800°C. In a few cases determinations were made

Refractories Division Program (*continued*)

(Tuesday Forenoon)

also at 300, 700, and 900°C. Six samples were tested through temperature regions of crystalline silica inversions at intervals of less than 100°C. The data show that the modulus of elasticity is affected greatly by the total silica content, modified by the form of the crystalline silica present and by the temperature. A general relation was found between modulus of elasticity, total silica, and linear thermal expansion.

12:00–12:30 P.M.

6. Constituents and Properties of "Radex" Magnesite Brick

By P. P. Budnikoff and B. J. Pines, Chemical Technological Institute, Charkoff, U. S. S. R.

Physical and chemical data on "Radex" magnesite brick are given, macro- and micro-structure studies described, and details of X-ray tests are noted. The brick is highly resistant to basic slag, but has little spalling resistance under rapid temperature fluctuations.

Tuesday Afternoon, February 19, 1935

2:00 P.M.–4:30 P.M.

Chinese Room

2:00–2:30 P.M.

7. Reliability of Measurements of the Thermal Conductivity of Refractory Brick

By J. B. Austin and R. H. H. Pierce, Jr., United States Steel Corp., Kearny, N. J.

In the report on the coöperative tests on heat transfer through refractories presented at the Symposium on Heat Transfer at the 1934 Annual Meeting, two important points, (1) the reproducibility of the measurement on a given brick in the same apparatus and (2) the possibility of variation in the brick tested at the different laboratories, were not adequately discussed. A thorough test of these points would require a large number of measurements on one brick and a rather large number of specimens with statistical treatment of the results, but a preliminary study on a smaller amount of data has led to some useful conclusions. The examination of a set of silica brick similar to those used in the coöperative tests and of the set of silica brick used by Wilkes in his measurements show that with our apparatus, which is of the Wilkes type, the individual readings taken on a single brick do not deviate from the average of a number of readings by more than 5%, and the real variation in the thermal conductivity of these brick appears to be less than can be detected in our apparatus. It is concluded, therefore, that the source of the differences existing in the values reported by the several coöperating laboratories lies not in the sample but almost entirely in the methods employed. In addition to the results on the silica brick mentioned, data are given for the thermal conductivity of three brands of silica splits and for fireclay splits. A description of the apparatus is given. (See *Jour. Amer. Ceram. Soc.*, **18** [2], 48–54(1935)).

2:30–3:00 P.M.

8. A Graphical Method of Calculating Heat Loss through Furnace Walls

By C. E. Weinland, Johns-Manville Research Laboratories, Manville, N. J.

When a wide range of temperatures is considered, difficulty is encountered in accurately representing the thermal conductivity of any material, the temperature-conductivity function of which is not a straight line relation. This difficulty can be obviated by use of the "true" conductivity function as defined herein.

The use of the "true" conductivity function confers the additional advantage that it makes possible a graphical method for the calculation of heat transmission through compound structures, under conditions of equilibrium heat flow. Though this is still a trial-and-error method, it is much more convenient and direct than any method proposed for this type of problem. The method is illustrated by the solution of a typical problem.

3:00–3:30 P.M.

9. Evidence of Variation of Thermal Conductivity with Heat Flow in Silicon Carbide Refractories

By F. L. Fritsche, Carborundum Co., Niagara Falls, N. Y.

Confirmation of the results of Hartmann and Westmont, who reported that conductivity increased with heat flow through silicon-carbide refractories, has been secured, using entirely different types of measuring apparatus. The effect is shown to be distinct from the variation of conductivity with temperature.

3:30–4:00 P.M.

10. Transformation of Aluminum Oxide from the Beta to the Alpha Form

By John Gallup, RCA Radiotron Co., Inc., Harrison, N. J.

Until quite recently it had not been known that beta alumina ever converted to the alpha form. This paper is the report of an investigation which shows that beta alumina when heated in a vacuum converts rapidly to the alpha form at temperatures as low as 1300°C. It was also found that the temperature at which rapid conversion starts rises successively in atmospheres of hydrogen, air, and argon. Petrographic identifications were checked by density determinations.

4:00–4:30 P.M.

11. The Effect of Insulation on the Silica Refractories of an Open-Hearth Steel Furnace Crown

By L. B. Miller, Johns-Manville Corp., Manville, N. J.

The use of insulation on an open-hearth steel furnace crown is desirable because of the large possible monetary savings involved through reduction in heat losses. The deciding factor in the use of insulation, however, is of a ceramic nature. It is the ability of the silica refractory to withstand the severe conditions imposed upon it by operating conditions which determines whether or not insulation may be used on the furnace crown. From the above considerations, the factors affecting the life and stability of the silica refractory of an open-hearth furnace crown are analyzed and found to be two, a chemical and a physical factor. The physical factor is temperature. Silica refractories taken from open-hearth furnace crowns

Refractories Division Program (*continued*)

(Tuesday Afternoon)

indicate three zones to have been formed due to temperature effects. The zone nearest the interior of the furnace, which is subjected to the highest temperature, is found by petrographic analysis to consist predominantly of cristobalite. The middle zone is predominantly tridymite and the outer one, quartz. The chemical factor is the formation of iron silicates from the metallic charge and the silica of the refractory and the effect of these silicates upon the silica refractory. The formation and properties of the iron silicates are viewed in the light of phase-rule knowledge of the system FeO–SiO_2. It is found that the effect of the iron silicate liquid formed is less destructive upon the refractory in an insulated than in an uninsulated furnace. From consideration of the several factors involved it is concluded that insulating an open-hearth furnace crown will prolong the life of the silica refractory.

Symposium on "Factors Affecting Rates of Change in Refractory Systems"

***Chairman*, Nelson W. Taylor, Pennsylvania State College, State College, Pa.**

Wednesday Forenoon, February 20, 1935

9:30 A.M.–12:30 P.M.

Chinese Room

9:30–9:45 A.M.

12. Introduction to Symposium

By Nelson W. Taylor, *Chairman*

Thermodynamics, atomic structure, and kinetics constitute the holy trinity of ceramic science. In its varied symposia of past years, the Refractories Division has stressed chiefly the first two aspects. On this occasion, the third will be considered.

9:45–10:00 A.M.

13. Reaction-Expansion Measurements on Chromite and Allied Spinels

By J. H. Chesters and C. W. Parmelee, Dept. of Ceramic Engineering, Univ. of Illinois, Urbana, Ill.

The rate of formation of spinel in mixtures of magnesia with alumina or chromic oxide (Cr_2O_3) was greatly increased by the addition of 2% of boric acid. When the three oxides were heated together in the molecular ratio ($2MgO + Al_2O_3 + Cr_2O_3$) reaction-expansion set in at a temperature much below that observed with the binary mixtures. The product appeared to be a mixture of green magnesium chromite with a pink colored spinel whose lattice edge was greater than that of magnesium aluminate but smaller than that of the chromite.

Test pieces made from unfired Cuban chromite began to shrink at 1300°C, and gave a final shrinkage of 2.2% after two hours at 1500°C. Microscopic examination showed that the serpentine had changed to a glass. The compensation of firing shrinkage by the addition of 20% of coarse Austrian magnesite or 10% of fine electrically fused magnesia was found to be due to the formation of a doubly refracting mineral resembling forsterite. With a 20% alumina addition, a firing expansion of 0.8% was obtained.

10:00–10:45 A.M.

14. The Mechanisms and Rates of Some Heterogeneous Reactions Applicable to Ceramics

By C. C. Furnas, Dept. of Chemical Engineering, Yale University, New Haven, Conn.

(*a*) Disintegration of fire brick by deposition of carbon

The reaction has a maximum rate between 450°C and 500°C. Experimental work showed that commercial fire brick could be completely shattered by the reaction in a few hours. Firing brick in reducing atmosphere reduces the rate of deposition.

(*b*) Rate of reduction of iron oxides

Rates are governed by character of oxide, size of particle, temperature, and composition of reducing gas. Data of rates are given for carbon monoxide.

(*c*) Calcination of limestone

Calcination takes place in a narrow band that advances toward the center of the piece at a constant rate, dependent only on temperature. Data are given for various temperatures.

10:45–11:15 A.M.

15. Solid Reactions at 1000 to 1200°C between MgO or BeO and Ni, Fe, Cr, Mn, and Their Oxides

By Louis Navias, General Electric Co., Schenectady, N. Y.

The elements Ni, Fe, Cr, and Mn and their oxides NiO, Fe_2O_3, Cr_2O_3, and MnO_2 in a finely divided state were brought into contact with granular fused MgO, in loose form and in pressed disks and into contact with slabs of high-fired MgO and BeO. The maximum temperatures reached were 1000°, 1100°, and 1200° in air firings. The degree of reaction was noted by the extent of discoloration of the MgO and BeO near the contact material. Ni showed the least reactivity, Fe and Cr came next, and Mn, the most reaction. The oxides gave the same order of reactivity, NiO; Fe_2O_3 and Cr_2O_3; MnO_2, the most. The elements in oxidizing caused more reaction than their oxides in all cases. There was less reaction with BeO than with MgO for corresponding contact material.

Firings were also made with these elements and oxides in contact with pressed disks of fused MgO but in a hydrogen atmosphere. Ni and Fe showed no reaction, Cr a very slight reaction, and Mn slightly more reaction. NiO and Fe_2O_3 are reduced to their elements without reaction, whereas Cr_2O_3 did not reduce and gave no reaction. MnO_2 became semi-sintered and gave a very slight reaction.

Other experiments were made by passing air or N_2, dry or through water, into mixtures of granular fused MgO and Mn, MnO_2, or Cr, respectively. At 1200°C reaction was greatest with moist air.

Refractories Division Program (*continued*)

(Wednesday Forenoon-Symposium)

11:15–11:40 A.M.

16. Effect of Repeated Firing upon the Specific Gravity and Microstructure of Some Aluminum Silicate Minerals

By Frank Harwood Riddle, Champion Spark Plug Co., Detroit, Mich., and Albert B. Peck, Univ. of Michigan, Ann Arbor, Mich.

Repeated firing of several aluminum silicate minerals to the same temperatures shows that the specific gravities of the fired products do not drop at the same rates. Petrographic-microscopic examinations show that this is due to different rates of dissociation in the various minerals. While these rates of reaction or dissociation can not be measured accurately, some idea of the relative rates can be obtained by comparison of the sizes of completely dissociated grains of the minerals or of the widths of the borders of the dissociation products formed around the grains. Furthermore, the effect of repeated firing upon the increase in size of mullite crystals formed when the minerals dissociate gives evidence concerning their rate of growth or probable refractoriness. These are described in some detail, and close correlation between them and the specific gravity changes are pointed out.

11:40–2:15 P.M.

17. Kinetics of Solid Phase Reactions of Certain Carbonates with Mullite, Silica, and Alumina

By G. R. Pole and Nelson W. Taylor, Dept. of Ceramics, Pennsylvania State College, State College, Pa.

Reaction-rate studies in the solid state between mullite, alumina, and silica with sodium carbonate and calcium carbonate were carried out in a manner similar to that employed by W. Jander. In the preparation of corundum-free mullite it was found best to start with a noncrystalline alumina and to stay in the composition triangle, mullite, anorthite, and silica.

The energy of activation of the silica-sodium carbonate solid-phase reaction is approximately 1.5 times that of the mullite-sodium carbonate reaction. The rate of reaction between crystalline alumina and sodium carbonate within the same temperature range was so small that it was not possible to calculate the energy of activation. The same condition was found in the reactions between silica, mullite, and alumina with calcium carbonate.

The results of these solid-phase reactions are in agreement with the work of W. E. S. Turner on glassmelting and offer possible explanations for the behavior of certain glass refractories when exposed to the dusts and vapors of various glass batches.

Wednesday Noon, February 20, 1935

Luncheon Talk and Business Meeting

12:30 P.M.–2:00 P.M.

Annual Business Meeting of the Refractories Division

Address on "Liquid Air"

By E. A. Harding, E. I. du Pont de Nemours & Co., Inc., Niagara Falls, N. Y.

This address will be illustrated by actual experiments showing the uses of liquid air.

Wednesday Afternoon, February 20, 1935

2:15 P.M.–4:40 P.M.

Chinese Room

2:15–3:00 P.M.

18. The Glassy Phase in the Manufacture and Use of Refractories

By George W. Morey, Geophysical Laboratory, Washington, D. C.

The material which constitutes the glassy phase at low temperatures is, at high temperatures, a manifest liquid whose powers of solution and corrosion are intimately connected with the development and strength in the firing of refractories and with their ultimate destruction, either by heat alone or by the action of a contained material. These various factors are discussed on the basis of the phase-equilibrium diagrams.

3:00–3:30 P.M.

19. Properties of Refractory Brick Suitable for Use in Glass Furnace Upper Structure

By W. L. Fabianic, Owens-Illinois Glass Co., Alton, Ill.

A practical investigation was conducted on the selection of those refractories most suitable for use in glass furnace port jambs, port sills, port floors, baffles, port nozzle sidewalls, port sidewalls proper, and top checker courses. These refractories are exposed to the destroying action of a viscous high-temperature basic slag and batch dust of a given composition. Over one hundred various brands of brick were tested, ranging in composition from a first-

Refractories Division Program (*continued*)

(Wednesday Afternoon)

grade fire brick to super-refractories of the 80% alumina class. The mechanical, chemical, physical, and mineralogical properties of these brick were studied. The results of the test determinations were checked by making actual service installations in operating furnaces. The performance of the refractories in these installations after ten months of service verified the test results to a remarkable degree. The mineralogical relationship of the minerals in the refractory as received was found to be of more importance than chemical or physical properties. A tentative method of determining the suitability of a brick for actual service by combining petrographic inspection with physical properties is suggested.

3:30–4:00 P.M.

20. Water Jackets for Glassmelting Tanks

By L. T. Sherwood, Pennsylvania Wire Glass Co., Dunbar, Pa.

Although the use of water jackets for glassmelting tanks has been commonly spoken of as "water cooling" with a view to preservation of the clay blocks, a materially different concept is herein explained. According to this concept, the water jackets are simply a reliable reinforcement instead of a preservative comparable to air cooling. Economic phases are also briefly discussed.

4:00–4:20 P.M.

21. Investigation of the Use of Magnesium Aluminate (Spinel) for Glassmelting Containers

By C. W. Parmelee and K. C. Lyon, University of Illinois, Urbana, Ill.

Crucibles were formed from spinel raw materials and commercial spinel grains, with and without admixtures of other chemicals. Bottle glass was melted in these and the behavior compared with similar containers made from fireclay grog and mullite (Corhart). The tests consisted of heating bottle glass in the crucibles at 1400°C for four hours and noting the appearance of the crucibles after the treatment. The results indicated that, under the conditions used, magnesia spinel is not suited for glass refractory material.

4:20–4:40 P.M.

22. Kyanite in Crucibles for Melting Glass

By S. R. Scholes, Dept. of Ceramics, N. Y. State College of Ceramics, Alfred, N. Y.

Excellent crucibles for experimental glassmaking have been made from calcined kyanite (60-mesh) 65 and plastic fire clay 35 by slip-casting in gypsum molds. The crucibles were fired at 1200°C before using. Details are given of sources of materials, procedure, and behavior in service.

Thursday Forenoon, February 21, 1935

9:30 A.M.–12:30 P.M.

Chinese Room

9:30–10:00 A.M.

23. High-Grade Ohio Refractory Clays

By E. J. Bognar, Corundite Refractories Co., Massillon, Ohio

The geological horizon of the refractory clays are listed in order of their depositions. The extent of their occurrence is described and shown on separate plates. The locations of the best clays in these horizons in Ohio are given, and the ceramic possibilities of these clays are listed. In general, Ohio clays have been belittled, and the data presented by the writer is to correct this impression. Good plastic clays occur in Ohio in much greater abundance than in Pennsylvania and Kentucky. Ease of accessibility to these deposits is pointed out, and a great future is predicted for the various clay beds.

10:00–10:30 A.M.

24. Firing Clay Refractories with By-Product Coke-Oven Gas

By C. E. Bales and W. T. Christian, The Ironton Fire Brick Co., Ironton, Ohio

By-product coke-oven gas with a B.t.u. value of 550 is now being successfully used in firing high heat duty clay refractories. It is more economical than natural gas and no difficulty is experienced in reaching the required high temperatures. A better looking product and a more uniform firing is secured by the use of this gas than by the use of coal. Combustion is apparently completed in the checkered fire boxes. Details of firing a kiln are given.

10:30–11:00 A.M.

25. Load Test Furnace

By J. L. Carruthers, Dept. of Ceramics, Ohio State Univ., Columbus, Ohio

A description is given of a simple, accurate, relatively inexpensive furnace and loading device for making the standard load test on 9-inch refractory brick.

11:00–11:30 A.M.

26. Advanced and Refined Technique in the Petrographic Study of Crystalline Refractories

By R. B. McCormick, Dept. of Geology, Univ. of Wisconsin, Madison, Wis.

The new technique for the determination of the refractive indices of minerals, as developed by R. C. Emmons of the University of Wisconsin, is described. The paper contains a discussion of immersion media and a description of the double-variation apparatus, the modified universal stage, and the smithsonite refractometer. Application of the technique to crystalline refractories is considered.

Refractories Division Program (*continued*)

(Thursday Forenoon)

11:30–12:00 A.M.

27. Some Geologic and Ceramic Data on Georgia Flint Kaolin

By W. H. Vaughan and D. J. Fargason, Dept. of Ceramics, Georgia School of Technology, Atlanta, Ga.

Some data on the probable deposition conditions of the sedimentary flint kaolins of Georgia is given, followed by typical chemical analyses and ceramic tests of specific gravity, dry strength, plastic properties, shrinkage and absorptions at several cone heat treatments, and pyrometric cone equivalent tests. The significance of these properties of flint kaolins in the manufacture of refractories is discussed.

12:00–12:30 P.M.

28. Determination of Alkalis in Silicates with Special Reference to High Alumina Refractories

By E. B. Read, Mellon Institute, Pittsburgh, Pa.

This investigation pertains to the detailed study of two methods used to determine alkalis in silicates. This work was prompted through the difficulty of obtaining complete decomposition of high-alumina refractory materials by the usual procedures.

It was found that high-alumina materials could be decomposed by the J. Lawrence Smith procedure with a single fusion, provided this is conducted at approximately 1200°C.

The second procedure has to do with the decomposition of the sample with a mixture of nitric, sulfuric, and hydrofluoric acids. In this procedure, magnesia is eliminated by precipitation with 8-hydroxyquinoline and the alkalis are weighed as sulfates. There are given experimental data pertaining to these procedures when used for the analysis of several types of materials.

STRUCTURAL CLAY PRODUCTS DIVISION AND TERRA COTTA DIVISION PROGRAM

***Chairman*, J. L. Carruthers, Ohio State University, Columbus, Ohio**

***Secretary*, D. A. Moulton, Iowa State College, Ames, Iowa**

***Chairman, Papers and Program*, W. H. Vaughan, Georgia School of Technology, Atlanta, Ga.**

Tuesday Forenoon, February 19, 1935

9:30 A.M.–12:30 P.M.

Parlor F

1. The Operation of Round, Downdraft Kilns in a Continuous Manner.

By Ralph M. Schory, Metropolitan Paving Brick Co., Minerva, Ohio

The author describes the kiln construction and the procedure used in firing, giving tabular data on the firing schedule, temperatures, and draft readings, as well as amount of fuel and fuel costs. Comparison data of temperatures in flues and crowns of the kilns are presented. The following conclusions are given: (1) Some fuel can be saved by passing the products of combustion from one kiln to another; (2) quality of ware is not affected by passing the products of combustion through the ware; (3) proper draft control, as a means of saving time and fuel, is more important in the average plant equipped with round, downdraft, periodic kilns, than is the saving of fuel by utilization of the combustion products; (4) time loss in kiln turnover more than offsets any gain in fuel economy by the use of this method; (5) the cost of fan operation, flue construction, maintenance, repair, and extra labor needed for proper operation, offsets any savings to be had from this method of firing clayware; and (6) the possibility for fuel economy in the average plant equipped with this type of kiln is considerable in amount and should be fully and intelligently exploited from the angle of draft control before spending large sums for new construction unless the new construction solves problems other than those of fuel consumption.

2. Pugging from an Engineering Standpoint

By H. R. Straight, Adel Clay Products Co., Adel, Iowa

Theories concerned with the inter-relationship of clay and adsorbed or occluded gases in the clay as it comes to the pug mill are discussed. Methods for replacing these gases with water in plasticizing the clay are given, with particular emphasis on their engineering and economic phases. The forming, drying, and firing characteristics of the ware may be improved by the proper application of pugging methods with particular reference to methods of adding the water, obtaining the proper pressure during hydration, and propelling the column without entrapping air. Improvements in the strength and frost resistance and economies in power generally result from proper pugging with scientifically designed blades for pug mills.

3. Production of De-Aired Sewer Pipe

By J. O. Everhart, O. S. U. Engineering Expt. Station, Columbus, Ohio

Observations made and data secured for a commercial installation at Uhrichsville, Ohio, are presented. Strength increases of 20 to 60% are possible, and absorption values were decreased from 1 to 4%. Blistering was entirely eliminated and body structure improved. Some recommendations regarding machine design and selection are included.

4. De-Airing of Floor Tile

By Douglas F. Stevens and Robert P. Stevens, Acme Brick Co., Danville, Illinois

The manufacture of shale and fireclay floor tile by the stiff-mud de-airing process is described. A discussion is also presented on the effect of de-airing on capacity and power requirements, changes in drying and firing behavior, and the resultant effect on the absorption, density, and wearing qualities of the product.

5. A Visual Method for Determining Die Strains

Discussion led by H. R. Straight, Adel Clay Products Co., Adel, Iowa

The writer demonstrates a method by which, using an undried or dried stiff-mud unit, an excess or deficiency of pressure from a stiff-mud die becomes evident. This method is as follows: Place a unit, preferably dried, in a pan in which there is a small amount of water. By covering the unit with a damp cloth so as to maintain 100% relative humidity, the unit will absorb sufficient water from below to allow the clay to become saturated. After the clay becomes saturated, it swells and becomes greater in volume where the pressure is greatest and shows a deficiency of swelling where there is a lack of pressure. The method provides a quick means of correcting strains before the units being processed are fired.

Structural Clay Products Division (*continued*)

Tuesday Afternoon, February 19, 1935

2:00 P.M.–4:30 P.M.

Parlor F

6. "Plastic Sulfur," Its Properties and Possible Uses as a Jointing Material

By W. C. Rueckel, O. S. U. Engineering Expt. Station, Columbus, Ohio, and W. W. Duecker, Mellon Institute, Pittsburgh, Pa.

A brief discussion is given of properties required for a good jointing material for paving brick and sewer pipe. Development of a series of sulfur compounds possessing plastic properties is described. Values for some physical properties of the materials are also included.

7. Mortars Suitable from the Standpoint of Water-Tightness in Unit Masonry

By L. A. Palmer, National Lime Assn., Washington, D. C.

A discussion is presented of published results of permeability tests made with 240 brick wallettes at the National Bureau of Standards. Fifteen mortars and five brands of brick were included in these tests. Some walls were made with porous brick laid wet. An equal number of test walls were made with porous brick laid dry. There are indications that water-tightness is more likely to result by adapting mortars to brick than by attempting to adapt the brick to the mortars. Mortars that are adaptable to a diversity of brick are important. The results of the permeability tests are considered in their relation both to mortar and brick properties as determined in a previous study by the author and also as observed by other investigators in this field.

8. Investigation of the Influence of Sodium Aluminate on Some Physical Properties of Fireclay Sewer Pipe

By W. K. Carter and G. H. Duncombe, Jr., National Aluminate Corp., Chicago, Ill., R. M. King, Ohio State Univ., Columbus, Ohio, and E. E. Hillyer, Clay City Pipe Co., Uhrichsville, Ohio

A laboratory study of the effect of sodium aluminate on the fired properties of a fire clay used in sewer pipe is discussed, especially with respect to the original kiln strength and strength permanency. The results of commercial applications of sodium aluminate additions in sewer-pipe plants are given.

9. Brick Manufacturers' Part in the Better Housing Program

By W. D. Richardson, Columbus, Ohio.

In the future more and better houses will be available to persons of low incomes. Shall these be machine-made houses, prefabricated of standard steel units, the surfaces of stainless steel or enamel and the interior filled with mineral wool or other insulating material, or shall they be of brick? Three solutions of the problem are presented, individually or collectively: (1) use of brick of larger surface area, *i.e.*, square-end brick with their thickness the same as their width or square-face brick with their thickness same as length—are proposed; (2) thin exterior and interior walls of brick, without plaster, so shaped as to be firmly interlocked by small tie brick, the intervening space being filled with insulating material; and (3) brick made of low heat conductivity by a large number of small vertical holes. Brick manufacturers must break away from established usage and create a demand for a better product at less cost, in order to adjust their business to this time of economic revolution and to meet competition with other building materials.

10. Converting Periodical Round Downdraft Kilns into a Continuous System of Firing

By Henry C. Kleymeyer, Standard Brick and Tile Corp., Evansville, Ind.

The objectives and advantages of this system are threefold: (1) reducing the cost of firing, (2) improving the quality of the ware, and (3) lengthening the life of the kiln. A saving of 20% in fuel and improvement in ware of 30% by actual records are demonstrated and, judging from the condition of the kilns which have been fired more than six times, their life will be prolonged at least 50%.

11. The Resistance of Clays to Gas Penetration

By Frederick G. Jackson, San Diego, Calif.

National Brick Manufacturers Research Foundation Business Meeting

Wednesday Forenoon, February 20, 1935

9:30 A.M.–12:00 M.

Parlor F

WHITE WARES DIVISION PROGRAM

***Chairman*, Edward Schramm, Onondaga Pottery Co., Syracuse, N. Y.**

***Secretary*, T. A. Klinefelter, National Bureau of Standards, Washington, D. C.**

***Papers and Program:* F. P. Hall, Onondaga Pottery Co., Syracuse, N. Y., and C. W. Parmelee, University of Illinois, Urbana, Ill.**

Tuesday Forenoon, February 19, 1935

9:30 A.M.–12:30 P.M.

Iroquois Room and Parlor G

1. A Method for the Accurate Measurement of the Plasticity of Clays

By J. W. Whittemore, Virginia Polytechnic Inst., Blacksburg, Va.

A method of measuring the plasticity of clays and mixtures of clays is presented. An apparatus is described by which the penetration of a constantly loaded hemisphere into a plastic clay mass during a definite time period is measured. The data presented indicate that the formula, $d = at^p$, expresses the relationship between d, the amount of penetration, during t, the time periods studied for any clay. Undoubtedly a is related to the load used, the diameter of the hemisphere, and some of the properties of the clay; p, in the formula, is a measure of the plastic properties of the clay. The data also show, through the variations in the value of p, the marked change in plasticity of a clay caused by changes in grinding, aging, and de-airing of a clay.

2. Plasticity and Crystal Form

By F. H. Norton, Massachusetts Institute of Technology, Cambridge, Mass.

In this study the plasticity, drying shrinkage, and strength were determined for a number of finely ground minerals. It is shown that plasticity increases with the perfection of the cleavage. It is also found that (OH) groups on the crystal surface increase the plasticity, *i.e.*, china clay is more plastic than graphite although both have the same plate structure. Both the drying shrinkage and dry strength are related rather closely to plasticity.

3. Mechanics of Plastic Clay

By G. W. Lapp, Lapp Insulator Co., LeRoy, N. Y.

This paper presents a physical picture of a plastic clay body relating the working properties and behavior of clays to the sizes, proportions, and arrangement of its particles. Deformation, shear, and differential directional shrinkage are discussed.

4. Plastic Flow in Nearly Dry Clay Bodies

By H. Thiemecke, Homer Laughlin China Co., Newell, W. Va.

Data on the plastic deformation under pressure of cylinders of a semivitreous body with varying moisture content and the pressure necessary to cause the cylinders to fail in shear are given.

5. Freezing Treatment for Clays That Are Difficult to Filter Press

By Paul E. Cox, Ceramic Dept., Iowa State College, Ames, Iowa

Georgia G-1 kaolin was reported as being so fine as to render filter-pressing of it very difficult. Stoneware clay, fresh from the pit, gives this same difficulty, whereas this same clay, once frozen, could be filter-pressed easily. G-1 kaolin, after one freezing, filter-pressed readily and worked well in the usual potting processes.

Tuesday Afternoon, February 19, 1935

2:00 P.M–4:30 P.M.

Iroquois Room and Parlor G

6. California Pyrophyllite

By L. M. Richard, Escondido, Calif.

A detailed description is presented of the location of an outcrop of pyrophyllite. Its chemical analysis is given as well as a physical analysis and the results of firing tests. The discovery of this commercial material in California affords a new mineral for refractory purposes, having purity of composition and controllable physical properties.

7. Some Effects of the Additions of Compounds of Zirconium, Titanium, Aluminum, and Barium to a Talc Body

By C. W. Parmelee and H. Thurnauer, Dept. of Ceramics, Univ. of Illinois, Urbana, Ill.

The purpose of the investigation was to develop a talc body having a low thermal expansion and a practicable firing range. Additions of $Al(OH)_3$, Alundum, BaO, TiO_2, ZrO_2, and $ZrSiO_4$ were made. Data relating to vitrification, thermal expansion, crystalline structure, and X-ray diffraction patterns are given. The introduction of Al_2O_3 lowers the thermal expansion but the firing range is short. Zirconium increases the firing range and the thermal expansion is low. The optimum amount of zirconium oxide desirable seems to lie between 20 and 30%. The use of titanium oxide was not advantageous.

White Wares Division Program (*continued*)

(Tuesday Afternoon)

8. Study of Some Talc Compositions

By F. J. Fallon, Dept. of Ceramics, Univ. of Illinois, Urbana, Ill.

Fluxing agents used in most steatite compositions contain alkalis which lower the electrical resistivity of these insulators. Attempts were made to obtain a vitreous steatite composition by additions of oxides containing no alkalis. The effect of grain size, liquids, and varying pressures was determined to obtain the optimum mixture which would produce the lowest absorption when fired to cone 14, and to this mixture the various oxides were added and the absorption and shrinkages obtained after firing to cones 13 and 14.

9. Lime-Free and Lime-Bearing Talc in Whiteware

By R. F. Geller and A. S. Creamer, National Bureau of Standards, Washington, D. C.

An investigation is being conducted to determine some of the more important effects of MgO, introduced as a lime-free talc or as a lime-bearing amphibole (marketed as talc), in whiteware of the wall-tile type. The maximum percentage of talc (or amphibole) in the bodies is 43, the minimum, 2.5. Each series of specimens was heated to 1120, 1180, 1260, and 1325°C (or approximately to cones 1, 6, 10, and 14).

The values obtained to date show that: (*a*) an appreciable variation of MgO content did not significantly alter the water absorptivity of the heated bodies, this property being influenced much more, relatively, by the CaO and by the alkalis in the feldspar; (*b*) the total linear shrinkage was decreased, for specimens heated to 1260°C, from a maximum of 8% for a body containing no talc to a minimum of 0.7% for a body containing 43% talc. The shrinkage also was influenced significantly by the CaO in the amphibole and by the alkalis in the feldspar; (*c*) moisture expansion was practically eliminated, but this must be accounted for in part by the low feldspar content; (*d*) the total linear thermal expansion to 700°C, considering specimens heated to 1260 and 1325°C only, was decreased from a maximum of 0.93% for a body containing neither alkalis nor MgO to 0.35% for a body containing 15% amphibole. In general, the thermal expansions increased as the percentage of talc or of amphibole was increased over 30% and, other factors being equal, expansions of bodies containing talc were higher than those of the comparable bodies of the amphibole series.

10. The Effect of a Tremolitic Talc in Wall Tile Bodies

By Donald Hagar, Zanesville, Ohio.

The use of a specific type of talc in wall tile bodies and the effect of various percentages on some of the more important properties of the bodies are described. The effect on shrinkage, absorption, modulus of rupture, permanent moisture expansion, and resistance to delayed crazing is shown. Conclusions indicate that talc increases the crazing resistance of wall tile bodies to which it is added.

Wednesday Forenoon, February 20, 1935

9:30 A.M.–12:00 M.

Iroquois Room and Parlor G

11. Specific Gravity as an Index for Slip Control

By J. R. Beam, Universal Sanitary Mfg. Co., New Castle, Pa.

The specific gravity of a casting body should be controlled within the limits of 0.003. To obtain this precision it is necessary to evacuate the slip before the determination.

12. Some Notes on High Specific Gravity Slips

By P. W. Dager, Champion Spark Plug Co., Detroit, Mich.

In attempting to reach the highest specific gravity obtainable for a given slip and chosen viscosity, a number of questions arise, as follows: (1) Is there any difference in the specific gravity obtainable if raw material, filter press cake, or pugged body is used in making up the slip? (2) Does the specific gravity of a slip affect the percentage of electrolyte required for minimum viscosity? (3) Does blunging a slip with excess water help to reach a higher specific gravity? (4) What does vacuum-treating a slip do to the viscosity of a slip?

13. Automatic Jiggering

By W. J. Miller, Miller Pottery Engineering Co., Swissvale, Pa.

The mechanizing of the pottery industry is discussed with regard to the similarities encountered in mechanizing the glass industry, and a brief description of an early two-line automatic jigger is given together with some operating difficulties and the sources thereof. The development of the present-day eight-line, combined multiple jigger and drier is briefly traced, together with a general discussion as to (1) the nature of the apparatus, (2) the manifold simplifications, (3) the commercial mass production of ware according to the Miller system, and (4) the extent and nature of manual intervention and the training required. The high-speed production of ware on a mobile single-line jigger is also discussed and the advantages thereof in small order production are pointed out as well as the advantages in training future operators. A short review is given of the jiggering and drying difficulties encountered in automatic machine production and the remedies successfully applied.

White Wares Division Program (*continued*)

(Wednesday Forenoon)

14. Development in Continuous Plastic Porcelain Manufacture

By C. H. Rapp and S. J. McDowell, A C Spark Plug Co., Flint, Mich.

A description and data are given on a continuous vacuum filter, vacuum pug mill, and tube-drier unit to manufacture small plastic porcelain shapes.

15. Rapid-Fire Miniature Tunnel Kiln for Firing Insulators at 1750°C

By R. R. Thomas, Jr., and Robert Twells, A C Spark Plug Co., Flint, Mich.

A miniature tunnel kiln was built to fire spark-plug insulators at a temperature of 1750°C with a complete firing cycle of four hours. The principal features of construction and operation of the kiln are described.

Wednesday Afternoon, February 20, 1935

2:00 P.M.–4:30 P.M

Iroquois Room and Parlor G

16. The System K_2O–PbO–SiO_2 Crystals and Glass

By R. F. Geller and E. N. Bunting, National Bureau of Standards, Washington, D. C.

A preliminary survey of this system indicates that it contains three ternary compounds having the molecular ratios 1:2:2, 1:3:6, and 1:1:4, respectively. The first, crystallizing as hexagonal plates, is uniaxial negative, has indices w1.93 ± 0.01, e1.72 ± 0.01, and the optic axis perpendicular to the cleavage. The second, crystallizing as well-defined fibers or lathes and resembling a short-fibered asbestos when crushed, has indices ranging from 1.69 ± 0.01 to 1.79 ± 0.01, extinction is parallel, and the optic axis is parallel with the longitudinal axis. The third crystallizes as rectangular platy granules of parallel extinction, and the indices range from 1.59 ± 0.005 to 1.65 ± 0.005. It is probably biaxial.

The linear thermal expansion to 300°C and the softening temperature of the three compositions, as glasses, are, respectively, 0.46% and 395°C, 0.28% and 461°C, and 0.24% and 517°C. The fields of stable and unstable glasses have been established as well as the approximate indices of refraction of representative compositions as glasses.

17. Effect of Solid-Liquid Ratio on Grinding a Ceramic Nonplastic Body

By Karl Schwartzwalder and P. G. Herold, A C Spark Plug Co., Flint, Mich.

A résumé of the method, covering the use of the Wagner turbidimeter in determining the grain-size distribution of finely ground ceramic nonplastic, is presented. Data on the grain-size distribution of a ceramic nonplastic dry-ground in a Hardinge mill and wet-ground with various solid-liquid ratios in a ball mill are given.

18. Effect of Furnace Atmosphere and Vacuum upon the Vitrification of a High Mullite Porcelain

By A. M. Hossenlopp and R. Russell, Jr., A C Spark Plug Co., Flint, Mich.

A high-mullite porcelain body was fired in various atmospheres and in vacuum. O_2, CO_2, and N_2 atmospheres, and vacuum were used separately for the firing, preceded by an oxidizing atmosphere up to 1000°C. The effect upon density, vitrification temperature, and range was determined. An oxidizing atmosphere in all stages of firing is advantageous in obtaining high density. Firing in vacuum lowers the vitrification temperature 100°C and increases the vitrification range 20°C.

19. The Development of a Decal Size over Which Liquid Gold Bands May Be Applied

By G. A. Loomis and Paul H. Mautz, O. S. U. Engineering Expt. Station, Columbus, Ohio

In this study promising results have been obtained in the development of a decal size which will not need to be removed by firing in the decal or otherwise removing the size before applying liquid bright gold or silver bands on semiporcelain dinnerware.

20. Some Further Permeable Pressing Experiments

By A. E. R. Westman, Ontario Research Foundation, Toronto, Canada

A continuation of the comparison of permeable-pressed and hand-molded commercial electrical porcelain disks showed the permeable-pressed disks to have higher dry strength, less tendency to deform in thin sections in the kiln, and as high and possibly higher fired strengths. Moisture gradients in thick permeable-pressed disks were shown to be negligible. Preliminary experiments on other aspects of permeable-pressing are also described.

21. Business Session and Committee Reports

PRESIDENTIAL ADDRESS FOR 1934–1935*

By W. Keith McAfee

Precedent dictates that the President of the American Ceramic Society shall present a "Presidential Address." Precedent does not, however, dictate exactly what form it shall take. I believe it should include two elements: a report of the President's stewardship, and his recommendations on future policy conceived as a result of a year's intimate contact with the problems of the Society. I shall therefore attempt to give first a brief summary of this year's administration.

A meeting of the Board of Trustees was held at the close of the Cincinnati Meeting and there have been three meetings of the Executive Committee throughout the year. The following decisions were made at these various meetings:

Deferred Payment of Dues

There are still a number of members of the Society who desire to continue their membership but who either can not pay all their annual dues in January or who can not at this time pay them at all. We have continued the policy of allowing instalment paying and, in some cases, deferred payment of dues. Some who were previously on the deferred dues basis have paid up.

Joint Meeting with Electrochemical Society

The Society participated jointly with the Electrochemical Society in holding a meeting at Asheville, North Carolina, in April. This constituted the Summer Meeting of the Society.

Glass Division

Our Glass Division again held a most successful interim meeting. In view of the excellent experience of this Division, the Board has recommended that our other Divisions also consider holding Summer Meetings.

Activities of New Committees

Our general committees have, for the most part, been active. Two special committees were created this year, the Committee on Statistics and, just recently, the Committee on Air-Borne Dust. With reference to the former, it was felt that the collection of statistical data compiled by all branches of industry in connection with NRA codes afforded an opportunity to integrate the ceramic industry and give us, for the first time, a knowledge of how large it was and approximately how many men and women it employed. It was obvious that this whole program could not be completed in one year. Nevertheless this Committee, under the able chairmanship of T. N. Kurtz, has made remarkable progress.[1]

The Committee on Air-Borne Dust has a two-fold duty. It is our contact with an inter-industry project to form a clearing house and stimulate research on problems of dust hazards. The Committee will also set our policy on the publication of information in this field. It is our duty to help guard against truly dangerous dust hazards and we should not follow entirely a policy of silence. On the other hand we must recognize that the very nature of silicosis makes damage suits brought in its name an ideal set-up for racketeering lawyers. Single sentences might be lifted from our publications and, shorn of their context, used before a jury of laymen with telling effect. It is our thought that a committee composed of members familiar with this field will be our best guard against such dangers.

Publications; Our Working Tools

We have given much thought to our policy on publications particularly with reference to our financial condition. The volume of both the *Journal* and *The Bulletin* has been limited. The December *Journal* contained only the Annual Indexes. The February *Bulletin* of this year is combined with the Annual Meeting Program. Both innovations saved the Society a great deal of money. The 1935 printing contract is reasonable in view of the higher cost under the Graphic Arts Code. It was signed only after a careful investigation and study.

Coöperation with Allied Organizations

The Board of Trustees passed, in coöperation with other technical societies, resolutions directed to the Congress calling attention to the necessity of providing adequate financial support for the National Bureau of Standards.[2] The decision of the Glass Division to coöperate with the International Commission of Glass Technology was

* Received February 2, 1935.

[1] See this issue, p. 80.

[2] See *The Bulletin*, **13** [6], 168 (1934).

ratified. Other coöperative activities are revealed in the committee reports.

Finances

It was apparent last February that our income could not balance our 1934 budget. We were faced with two alternatives—either to greatly curtail our activities or to draw further on our reserves. The annual budget had been drastically cut early in 1932 when income fell off sharply. A careful analysis of our expenses showed that further reduction in expense could only be made by a very appreciable reduction in service to our membership and the ceramic industry. The Board decided that the ceramic industry, faced with more and more acute competition from other materials, could ill afford such a curtailment. It also felt that it would handicap our Membership Committee in attracting new members as business gradually recovered. The total of the 1934 budget was therefore fixed at approximately the same figures as the preceding year and our attention was directed to increasing our income so that we would draw as little as possible from our reserves. The results of the year with comparisons of previous years are as follows:

	Total income	Total expense	Surplus
1931	$45,083.52	$43,633.56	$6,234.33
1932	34,255.72	33,173.61	7,316.44
1933	27,813.26	30,063.13	5,066.57
1934	27,895.88	30,953.91	2,008.54

The General Secretary's office and the Membership and Advertising Committee have been extremely active. Results naturally lagged behind effort and, although the results are now becoming most gratifying, it was necessary for the Board to authorize the deposit of $3500, derived from the surrender of called bonds, to the credit of our general funds. This enabled us to finish the year with a balance sheet satisfactory except for the size of the surplus account.[3]

The Membership and Advertising Committee under the chairmanship of R. B. Carothers has accomplished much. Our advertisers have been very loyal to us. There is enough income already in sight to balance last year's budget, but the 1935 budget must be larger, in view of mounting costs, if we are to render the same service. If we follow through the theory that our reserves are for the purpose of carrying us through lean years, we must start to rebuild them at the earliest possible time. The Membership and Advertising Committee will need your full cooperation.

Product and Functional Programs

J. C. Hostetter pointed out, in his Presidential Address of last year,[4] the growing conflict in our activities between product distinctions and functional distinctions. It seeems logical to conclude that, as our technology becomes more and more fundamental, these product distinctions will be less important. If our object were only to develop technology, it might be concluded that the need for our product Divisions would eventually disappear. We are equally concerned, however, with the application of technology and this will vary with the different manufacturing methods. It is my opinion that we shall always have need for these product Divisions. I believe, however, that more of the time of our Annual Meetings should be devoted to general sessions. These would be promoted by our various functional committees and would be held at the expense of part of the time now devoted to the separate Division sessions. The time lost to the Division sessions could be more than made up by Division Summer Meetings similar to those so successfully held by the Glass Division. These general sessions might consist of the whole Society or joint meetings of two or more Divisions, as the subject warranted.

This growing tendency is quite apparent in our programs. I believe we should frankly recognize it and anticipate it in our future plans. Possibly the Materials and Equipment Division should consider changing its status to that of a functional committee, similar to the Committee on Industrial Management. Perhaps the Art Division should do likewise. If their respective members joined the other six Divisions, they would still have a voice in electing Trustees to the Board.

General Committee Activities

Our general committees are important forces in maintaining the cohesion of the Society. Most of our active work is done by Division committees. Most of our general committees as set up consist of a chairman appointed by the administration

[3] See Audit Report, p. 88.

[4] See *The Bulletin*, **13** [2], 34 (1934).

and the chairman of each of the corresponding Divisional committees. The general committee should concern itself with broader matters of policy and, in some cases, either stimulate Divisional committee work or sponsor general sessions. In order to promote continuous progress the personnel of these committees should be changed as little as practicable.

A few of our committees are appointed outright and are, and should be, self-motivating. The Publications Committee is an example. We are fortunate that this Committee under the chairmanship of Louis Navias has been extremely active and proficient. A few of our committees are frankly "stand-by" in character. The rules Committee seldom initiates an activity but always stands ready to study and attempt to work out any problems referred to it. Some of our other committees temporarily find little to do. The Committee on Industrial Management has had no opportunity to hold general sessions for the last two years. This Committee will, in the future, be asked to take an active part in supplying material for *The Bulletin*.

It is impossible to carry on the work this Society should do and rely entirely on the pages of *The Bulletin* to maintain activity between Annual Meetings. We are serving a billion-dollar industry, one of the largest in this country. We are trying to keep it not only in step with general industrial development but as far as possible ahead of this development. We are trying to protect it against competitive products that will surely take our markets from us if we do not use our best ability to reduce cost, make better products, and put in the hands of our prospective customers full information about the worth of ceramic products and, what is perhaps more important, competent engineering information so they can be used intelligently and with confidence. This is not a once-a-year job. It requires year-around activity and the committee form of organization is the best so far devised. I want to make my strongest plea to strengthen our committee work. If the need for any of the committees passes, abandon them, but by all means create new ones when the occasion arises.

The Bulletin

The Bulletin has been gradually evolving into a new tool of the Society. The Board of Trustees is relying much on our functional Divisions and committees to develop articles of general interest that will appeal to factory executives. It is our vision that *The Bulletin* is the best means of promoting the application of technology. This policy should, I believe, be emphasized without losing sight of the fact that *The Bulletin* keeps our membership informed of the activities of the Society between Meetings and is the contact between the Board, the committees, and the membership at large.

Our Secretarial and Editorial Set-Up

Two things above all others have impressed me this year: the amazing amount of proficient work accomplished by the comparatively small staff of our Columbus office under the direction of the General Secretary, Ross C. Purdy, and the equally proficient work of our Division Editorial Committees. To those in these groups belongs most of the credit for the high esteem in which the Society is held by those outside our ranks

Professional Engineers

Many States are passing laws requiring registration of professional engineers. If this is done sensibly and properly, we must applaud it. There are the usual discrepancies between the different States. Most States are setting up subdivisions of engineering and apparently little regard is given to the ceramic engineer. Our General Secretary has been keeping the Executive Committee in touch with this situation, but I believe it should be handled by the Fellowship of the Society. It would seem to be a logical activity for this group. Ohio has already specifically listed ceramic engineers as a group, and other state boards have it under advisement, due to the activity of Mr. Purdy.

Local Sections and Student Branches

I urge the Society to strengthen its Local Section and Student Branch activities. The Committee on Sections and Divisions, under the chairmanship of Past-President Poste, has been quite active. The California Section and the Michigan-Northwestern Ohio Section have again become active. The Central Ohio Section has been initiated. This Committee is holding three important conferences during the Buffalo Meeting, three precedents which I hope will be continuously followed. There will be a conference of all Division officers with their elected successors.

There will be a conference of Local Section delegates. There will be a dinner-meeting of representatives of our Student Branches sponsored by the Alfred Student Branch.

In closing, I want particularly to thank the various officers of the Society, the members of the Executive Committee and the Board, and the committee chairmen for their whole-hearted cooperation and counsel. I want to thank the membership for the opportunity of gaining a larger vision of the ceramic industry and of the vitally active American Ceramic Society—an opportunity one can only get by serving a year as your President.

UNIVERSAL SANITARY MANUFACTURING COMPANY
NEW CASTLE, PENNSYLVANIA

COMMITTEE REPORTS FOR 1934–1935

REPORT OF THE COMMITTEE ON CERAMIC EDUCATION

Aims

The aims of a committee on education are difficult to define and realize. This is especially true of those who are removed from the sphere of teaching. It must be stated frankly that the Chairman of this Committee has not been active in developing this subject in any useful way during the past year. Beyond carrying on some correspondence nothing of interest has been achieved. As a Committee we have confined ourselves to a suggestive attitude and have not presumed to voice any specific demands as to instruction in ceramics. This we believe is as it should be.

Interest has been aroused in the subject of fundamental studies woven into the courses of study. It seems that some curricula have been modified in this sense which is very gratifying.

The Syllabus

An attempt has been made to prepare a syllabus dealing with the field of clay products technology. At first it was thought to be a simple task to prepare a brief outline of the topics involved but the incompleteness of the attempt was so obvious that it was necessary to realize that the work requires the coöperation of a number of workers. Professor Parmelee, Dean of the Fellows of the Society, was kind enough to suggest such an organized effort and aided with several pertinent recommendations.

Ceramic Courses Approved by New York State Board

One of the interesting results to be noted in connection with ceramic education is the approval of a number of courses in ceramic engineering by the University of the State of New York. This action has been brought about through the energetic activity of the Secretary of the Society assisted by several of our members. The practical result of this recognition is of importance since it makes possible the licensing of graduates who pass the examination to practice as engineers in the state of New York.

Ceramic Courses in High Schools

An interesting topic has arisen in connection with the ceramic courses given in high schools. Attention has been given this matter by A. S. Watts in a statement to the Ohio Ceramic Industries Association. He describes the situation accurately as it existed in the high school at East Liverpool, Ohio, and similar institutions. The two chief disadvantages of the high-school courses have been the inability of the graduates to secure positions in the industry and, at the same time, the impossibility of admitting them to college courses owing to the deficiencies in the curriculum.

Professor Watts suggests that high-school courses in ceramics be limited to studies teaching plastic modeling, appreciation of form, symmetry and color harmony, with suitable studio exercises, but that no attempt be made to develop manual training or trade-school education. He also advocates that no replacement be made in any of the subjects required for college admission. From the experience of the ceramic course formerly given in East Liverpool, Professor Watts' suggestions seem to be very appropriate.

The immediate need in connection with the work of this Committee would seem to be the completion of the syllabus which has been started, to be followed by others on ceramic technology, and the encouragement of the writing of adequate text books. It would seem to be especially desirable to secure such industrial coöperation to prospective authors so that their texts shall be modern and authoritative.—A. V. BLEININGER, *Chairman*

REPORT OF COMMITTEE ON GEOLOGICAL SURVEYS

New surveys, investigation and research on the geology, occurrence, and preliminary testing of ceramic raw material resources during 1934 by state, federal, and educational institutions were still considerably curtailed due to lack of funds.

As in previous years, all states maintaining geological surveys were canvassed as to work under way or contemplated. In some cases where the state geological survey had been discontinued, however, the survey had been reestablished during the year.

At the time of compiling this report replies had not been received from all of the states canvassed, so a supplemental report will have to be submitted.

As indicated under the respective states, advantage was taken of PWA or FERA funds to carry on ceramic material surveys. This was done by coöperation between the

state and the U. S. Geological Survey. In each case the direct charge of the work was under the supervision of the U. S. Geological Survey. It was impossible to determine what, if any, of these funds will be available for 1935.

During the year the Committee assisted in the studies of the geological correlation of fire clays being carried on by the Department of Geology at Cornell University.

Following are reports of activities in the states answering the Committee's questionnaire and information obtained from the U. S. Geological Survey and other research organizations:

Illinois

The State Geological Survey Division at Urbana has been carrying on the following investigations during 1934, which will be continued into 1935:

(*a*) The petrology of Illinois clays and its relation to their ceramic properties and utilization.
(*b*) Methods of decolorizing southern Illinois silica and clay.
(*c*) Suitability of Illinois clays and shales for the production of lightweight fired clay aggregate.
(*d*) Sources and character of Illinois bonding clays for use in synthetic molding sand.
(*e*) The properties of southern Illinois ganister and novaculite affecting their use in the manufacture of refractories.
(*f*) The properties of southern Illinois silica affecting its use in pottery bodies.
(*g*) The use of fluorspar in enamels.
(*h*) The chemical properties of fluorine affecting the utilization of Illinois fluorspar.
(*i*) The clay and shale resources of extreme southern Illinois.
(*j*) The influence of fluorspar on silicate melts.
(*k*) Areal studies of clay and shale resources in various quadrangles being mapped geologically.

During 1934 approximately $10,900 was expended on this work, including field and laboratory work and publications, and during 1935 approximately the same amount will be available.

During 1934 the following reports were published:

(*a*) Rock Wool from Illinois Mineral Resources: Geology by J. E. Lamar and H. B. Willman; Chemistry by C. F. Fryling; and Economics by W. H. Voskuil. *Ill. Geol. Surv. Bull.*, No. 61, 262 pp., 34 figs.
(*b*) Mineral Construction Resources and Products of Illinois by M. M. Leighton and C. W. Parmelee, Contributions to 2nd Ann. Min. Ind. Conference, Home Building in Ill., *Ill. Geol. Surv.* (1934).
(*c*) Structural Clay Products Industry in the New Home Building Movement by W. H. Voskuil (same reference as (*b*)).
(*d*) Investigations of Illinois Mineral Resources for Improved or New Construction Materials: Clays and Shales by R. E. Grim; Ceramic Products by C. W. Parmelee; Insulating Materials by F. H. Reed (same ref. as (*b*)).
(*e*) Illinois Mineral Industries in 1933 by W. H. Voskuil and A. R. Sweeny, *Ill. Geol. Surv. Rept. of Invest.*, No. 36, 69 pp., 3 figs. (1934).
(*f*) Petrology of the Kaolin Deposits near Anna, Ill., by R. E. Grim, *Econ. Geol.*, **29** [7], 659–70 (Nov., 1934).
(*g*) Petrographic Study of Clay Minerals—a Laboratory Note by R. E. Grim, *Jour. Sed. Petrol.*, **4**, 45–57 (1934).

Indiana

No special field investigations have been carried on but state samples of ceramic raw materials received at the offices of the Survey were tested. This work will be continued in 1935. A report on the "Clays of Indiana" was published in 1934.

Iowa

The Iowa Geological Survey during 1934 continued a study of the geology of the clays and shales of Iowa. This work covers studies of the shales as they are exposed in the pits of operating plants, the collection of samples for testing, and the subjection of these samples to ordinary ceramic tests. This work will be continued in a limited way only during 1935, due to small funds available. The work has been carried on partly with the attempt to discover, if possible, deposits of the less common clays not at present known to exist in the State. This work has been done by C. S. Gwynne of the Iowa State College for the State Survey.

Kentucky

The Department of Mines and Minerals, Lexington, Ky., has only recently been created, and this new Department desires to expand their work so as to make a study of the mineral industries of the State, including ceramic raw materials. The Department is anxious to receive any information that will assist them in formulating plans for the development of ceramic raw materials.

Louisiana

The Geological Survey of Louisiana was established during 1934 as a division of the Department of Conservation. As yet no definite program on ceramic materials has been formulated. Funds have been provided for work of the Survey, and the Survey will work in coöperation with the School of Geology of Louisiana State University.

Missouri

During 1934 the Missouri Geological Survey completed a rather extensive investigation of the bleaching clays in southeastern Missouri and revised the geology of this area. Results will appear in the 58th Biennial Report of the Survey which will be available after February 1. Samples of the bleaching clays will be tested for their possible utilization in fired ware.

A brief study of the deposits of halloysite in Lawrence County was made, and the results will be published in the above report.

During 1934 approximately $3000 was spent in field and laboratory work on the above projects. Part of this was State funds, the remainder made possible through projects sponsored by CWA and FERA.

There has also been completed, as a State project, a microscopic study of the flint and diaspore clays of north central Ozark region. The results of this will be published in the Biennial Report referred to.

During 1935 it is hoped to continue a microscopic study of the fire clays of the State, and a ceramic study of the clays in the Southeastern and other portions of Missouri.

Nevada

The Bureau of Reclamation of Nevada is issuing a report which will, among other things, comprise a field study of the mineral resources in the region tributary to Boulder Dam. This particular portion of the report was published by the U. S. Geological Survey on Aug. 24, 1934.

A paper describing the origin of the dumortierite deposits at Oreana, Nev., by Kerr and Jenny, should appear in an early issue of *Economic Geology*.

New Mexico

During the spring of 1935 the State Bureau of Mines and Mineral Resources, Socorro, New Mex., will issue a general report on the nonmetallic minerals of New Mexico, which will include a section on clays.

New York

Columbia University, Department of Geology and Mineralogy, has been carrying on a coöperative study with the Illinois Geological Survey, of the mineral constituents of Illinois soils. Previous X-ray studies conducted at Columbia University and additional work carried on during the last year have been freely drawn upon in this investigation.

Ohio

The Geological Survey of Ohio has completed an investigation of the shales and red-firing materials of the State. The report is practically ready for print, but no funds are available for publication.

Pennsylvania

The State Geological Survey in 1934 published *Bulletin* No. 112 on "the White Clays of Pennsylvania" by Henry Leighton. During 1934 a survey of the central counties and tests of all their clays was completed. During 1935 it is probable that a report on the clays of Erie, Crawford, Mercer, Venango, Warren, McKean, Cameron, Elk Center, Clearfield, Cambria, and Somerset Counties will appear.

Texas

The Bureau of Economic Geology, University of Texas, is issuing at this time a volume on economic geology in which the geologic relations of ceramic raw materials will receive attention.

Washington

Work on the geology of the clays of Washington is being conducted by Sheldon L. Glover of the Washington State Geological Survey. The Northwest Experiment Station, U. S. Bureau of Mines, in coöperation with the University of Washington and the State Geological Survey, has undertaken surveys of (1) the talc and soapstones of the Pacific Northwest, and (2) the silica sands of the Pacific Northwest. A report of a similar coöperative problem, "Kaolin and China Clay in the Pacific Northwest," by Hewitt Wilson, was published by the University of Washington, Engineering Experiment Station, as *Bull.* No. 76, Sept., 1934. It is expected that the appropriation amounting to over $3000 will be continued.

U. S. Geological Survey

In the Boulder Dam area, including parts of California, Nevada, Utah, and Arizona, the mineral resources within a radius of approximately 200 miles of the Dam were studied at the instance of the Bureau of Reclamation. Among the nonmetallic mineral resources investigated were limestone, magnesite, brucite and dolomite, salt, strontium-bearing minerals, borates, kyanite, feldspar, bentonites and other bleaching clays, and volcanic ash. A brief summary of the results of this work is being published by the Bureau of Reclamation. A paper on the strontium deposits is to be presented before the February meeting of the American Institute of Mining and Metallurgical Engineers by B. N. Moore.

A report by Mr. Moore of somewhat earlier investigations of nonmetallic mineral resources in eastern Oregon is in course of publication as a bulletin by the Geological Survey.

The Public Works program in the eastern states included studies of talc in St. Lawrence County, N. Y., of ball clays, etc., in western Kentucky, Tennessee, and Alabama, of paper clays in South Carolina, and of bleaching clays in Kentucky, Tennessee, Mississippi, Alabama, South Carolina, Georgia, and Florida, of kyanite and vermiculite in Georgia and some adjacent States, of graphite in Alabama, and of phosphates in Florida. In the southwest a study of bleaching and other clays in the San Antonio, Texas, area was made.

Brief reports on these different investigations are in course of preparation. Some of these, for example that on kyanite and vermiculite in Georgia, will be published by the states involved. Most of them, however, will presumably be published in the form of press notices by the Geological Survey.

Battelle Memorial Institute

Considerable investigative work has been done on the dressing of refractory raw materials and ceramic materials, with the objective of applying methods of concentration to improving their grade.—*Committee on Geological Surveys:* W. M. Weigel, *Chairman;* J. E. Lamar, H. Ries, J. W. Whittemore, and Hewitt Wilson.

REPORT OF COMMITTEE ON SECTIONS AND DIVISIONS OF THE AMERICAN CERAMIC SOCIETY FOR 1934

To the Trustees of the American Ceramic Society.

Gentlemen: Though there has been an effort throughout the year to keep in touch with the Local Sections and Student Branches, and to revive interest in those which had become inactive, the major portion of this report comes through data submitted by the several organizations as reports of the year's work. No effort has been made by your Committee to organize new units, but local interest for Sections has developed to two points, one instance resulting in the formation of a new Local Section.

The numerical data from the various Local Sections and Student Branches are presented in tabular form and certain other facts are otherwise submitted. A complete set of reports as received will be placed on file in the offices of the General Secretary of the Society.

Local Sections

Cleveland

There has been a consistent effort to revive the Local Section centering at Cleveland but no person has been found who would take the responsibility of handling the situation locally.

San Francisco and Arkansas

Nothing further has developed with reference to the organization of a Section at San Francisco, mentioned in our report of last year. Interest in the formation of an Arkansas Section developed early in the year but did not mature.

Central Ohio Section and Active Sections

A new unit has been organized under the name of the Central Ohio Section, facts concerning which are included in the accompanying tabulation.

In addition to the formation of the above new Local Section, the outstanding facts are the excellence of the Pittsburgh Section and the marked revival of interest with the Michigan-Northwestern Ohio and California Sections.

Pittsburgh Section

The Pittsburgh Section is a member of the Pittsburgh Affiliated Technical Societies and has extended its usefulness beyond its immediate territory by coöperating with the School of Mineral Industries at Pennsylvania State College in sponsoring the Ceramics Section of the Fourth Pennsylvania Mineral Industries Conference. Several other sections have held joint meetings with other local technical organizations.

General Information

Those interested in the more detailed statements as to types of meetings, plans for the future, and the like must refer to the individual reports submitted herewith. Our survey of these papers prompts us to urge upon the Local Sections coöperation with other local technical organizations and near-by ceramic schools, as location may permit, and to call special attention to the problem of Local Section finances, as has been suggested by one of the Sections.

The data show that some Sections get along in an unknown way with no stated financial plan, one assesses those present at each meeting, several have dues at $1.00 per year, and one at $2.00. It is suggested that the Trustees consider making available to each Local Section a definite amount per year for each American Ceramic Society member identified with that Section. This plan is used by other societies. Financial background is thus afforded each Section; an inducement is created to get Society members into Local Sections and to increase membership in the parent Society by activity on the part of the Sections; and the establishment of new Sections in localities containing a reasonable number of American Ceramic Society members is stimulated. Obviously Local Sections should charge local dues to those nonmembers of the Society who are members of the Section.

Some means of coördinating the work of Local Sections should be developed. We have no concrete suggestions to offer. As a step in this direction a conference of Local Section officers is being planned for the Buffalo meeting (see General Program Outline).

Student Branches

No effort has been made to organize new Student Branches. A study of the case of the inactivity of the group at Georgia School of Technology has failed to indicate the revival of that Branch.

Our file of reports indicates all of our active Student Branches to be healthy. In at least one case membership and attendance are required of all ceramic students above the freshman class. Some Branches are responsible for all of the student activities of the ceramic department, and often arrange representation in interdepartmental affairs. The reports contain too much detail to summarize. Among suggestions as to how the parent Society can help the Student Branches is the matter of assistance in obtaining outside speakers. The American Chemical Society has a plan for securing speakers for its local sections. Some effort along this line could be made for the benefit of our Local Sections and Student Branches and the former, in many cases, could be of assistance to the latter.

The students are taking an increased interest in the Annual Meetings of the Society and many suggestions have been submitted. In addition to social contacts such as have been provided in the past two years, there is a desire for special technical sessions for the students. The Meeting Program for 1935 provides for the students more adequately than formerly. These details have been worked out by this Committee in coöperation with the New York State College Branch which is to act as host to the other students.

We continue to feel that the cultivation of our Student Branches is one of the most useful and profitable functions of the Society in terms of long range planning.

Industrial Divisions

Your Committee has not extended its activity to include contact with the Division organizations. The functions of the Art and Materials and Equipment Divisions which cut across the interest of the other Divisions has received attention by others, and we are pleased to note the excellent work which Mr. Barringer has done in the former case. Our files tell us that a study of the facts concerning the Materials and Equipment Division may be expected to result in proper adjustments.

A better coördination of the Divisions is needed and to this end a conference of Division officers has been planned for the 1935 Meeting. Several pertinent subjects are to be presented by qualified members of the Society.

Summary

By way of summary, we have eight active Local Sections and the same number of healthy Student Branches. In addition, the students of one college are identified with a general organization of overlapping interest.

The average Local Section has 63 active and 28 associate

TABULATION OF REPORTS

Local Sections	Membership: Active	Associate	American Ceramic Society	Dues	Meetings Held	Average Attendance: Members	Guests	Total Attendance
Baltimore-Washington	40	100	34	$1.00	2	30	10	80
California	65	75	36	1.00	5	65	5	350
Central Ohio	40		40	*a*	1	40		40
Chicago	14	25		2.00	3	10	20	90
Michigan-Northwestern Ohio	98		40	*b*	4	20	15	140
Pacific-Northwest	38	21	7	2.00	2	49	4	106
Pittsburgh	175		122	1.00	7	35	2	259
St. Louis	30			.50	1	15		15
Total	500	221	279		25	264	56	1080
Average	63	28	47*c*		3.4*d*	33	7	

Average Local Section
Members
Active 63
Associate 28
American Ceramic Society 47
Meetings 3.4
Attendance
Average 40

a = no fees or dues collected.
b = no regular dues; small fee collected at each meeting.
c = average of the 6 reporting.
d = Central Ohio figures not included; organization meetings held in 1934.

Student Branches								
Alfred	204		1	0.50	8	95	10	840
Illinois	41	6	5	0.50	4	25	3	112
Iowa State	14*a*		4	*b*	27	14	1	405
Missouri School of Mines	11	2	2	1.00	9	12	2	126
North Carolina State	24	14		2.00	7	30	1	217
Ohio State	32		5	1.50	8	18		144
Penn State	21	6	4	*c*	9	17	3	180
Rutgers	19	5	4	1.00	6	15	20	210
Univ. of Washington (*d*)	45		3	1.00	18	18		324
Total	411	33	28		96	244	40	2558
Average	46	4	3		10.7	27	4+	

Average Student Branch
Members
Active 46
Associate 4
American Ceramic Society 3
Meetings 10.7
Attendance
Average 32

a = membership and attendance required of all ceramic students above freshmen.
b = assessments as required.
c = no fees or dues.
d = ceramic students coöperate with Mines Society to which statistics apply.

members; with 47 members of the parent Society. It holds more than three meetings a year with an average attendance of 40.

In like manner, the average Student Branch has 46 active and 4 associate members, with 3 Society members. Eleven meetings were held with an average attendance of 32.

The total attendance at Local Section meetings during 1934 was 1080, and the corresponding total for Student Branches was 2558, a grand total of 3638.

These figures are based on the tabulation of several individual reports (see table), which also contain much valuable information which should become available. Doubting the advisability of publishing more than the tabulated summary, we recommend that the Secretary of the Society have multigraphed copies of portions of the reports headed Meetings and General Remarks, together with supplementary statements in certain cases, sent to the Local Section and Student Branch chairmen and councilors.

Respectfully submitted,

EMERSON P. POSTE, *Chairman*

ANNUAL REPORT OF THE STANDARDS COMMITTEE OF THE AMERICAN CERAMIC SOCIETY FOR 1934–1935*

The activities of this Committee have been divided into three groups, (1) Subcommittee "A," Nomenclature and Definitions, (2) Subcommittee "B," Raw Materials Specifications, and (3) General Standards presented by the Divisions.

Subcommittee "A"

(1) Reporting for Subcommittee "A," consisting of L. E. Barringer, G. A. Bole, and J. C. Hostetter, the work of Selick Perkal, Kharkov, U.S.S.R., on "Silicate Terminology" was examined and we found that only a limited amount of the material is suitable for incorporation in the Society's Book of Standards, and that this material can not be considered collectively. Therefore, it was agreed that the individual definitions of Dr. Perkal shall be submitted with other definitions in our Committee proposals pending the time when the ceramic material in Dr. Perkal's "Silicate Terminology" can be published in the *Bulletin*.

This Subcommittee next considered the collection of definitions presented by H. T. Coss, entitled "Definitions Pertaining to Heat Effects on Ceramic Materials." After much study and many revisions by both the Committee and other members of the Society, the assembled material was published in the December, 1934, *Bulletin* for general study and comments.† The responses are being received in encouraging numbers. Interested groups outside the Society are also being urged to offer their criticisms.

Within the Subcommittee a study was undertaken of definitions for the following: "Ceramics, Vitrification, Plasticity, Refractory, Clay, and Fusion." Progress is

* Received January 28, 1935.

† See *The Bulletin*, **13** [12], 340–43 (1934). *Erratum:* p. 341, Section (4) Congruent Melting Temperature, paragraph (*b*) should read as follows, "The characteristic temperature, under a given external pressure, at which the liquid and crystalline phases of the same composition are in equilibrium with each other." The word "not" as printed should be deleted.

reported, but the Committee is not prepared to present any recommendations.

Subcommittee "B"

(2) Reporting for Subcommittee "B," consisting of H. M. Kraner, A. V. Bleininger, and E. P. Poste, this Committee undertook a study of Raw Material Specifications for Diaspore. In this they encountered opposition from the American Refractories Institute, which urges that A.S.T.M. handle all specifications on refractories. The Committee activity was therefore halted. The Standards Committee was urged to reopen the subject of Moisture Content of Ball Clays which was considered in 1930. This was referred to Subcommittee "B." No action has been reported.

General Standards Committee (Division Representatives)

Reporting for the Standards Committee of the Society, this Committee has served several national organizations in search of ceramic material and data and is now cooperating with the A.S.M.E. in Tests for Drying Equipment. It has contacted various international organizations in matters of Standards, and is coöperating in the planning of program material for the I.A.T.M. Congress in England in 1936 as a part of the International Standards Association. The Standards Committee is constantly urging the correct use of ceramic terms, but until the Society will endorse such terms with definitions little success can be expected. No material has been passed by the Divisions and submitted to the Standards Committee, hence we have no progress to report as to Division Standards.—ARTHUR S. WATTS, *Chairman*

REPORT OF THE COMMITTEE ON STATISTICS FOR THE CERAMIC INDUSTRY

The Committee endeavored to get complete data of recent date on the eight major Divisions of the industry, namely, Art, Enamel, Glass, Materials and Equipment, Refractories, Structural Clay, Terra Cotta, and White Wares.

The information obtained from the various trade associations, institutes, and code organizations was examined and found complete in some cases only. However, the reports from the United States Census Bureau for the years up to and including 1929 show the number of establishments, number of employees, amount of payrolls, and value of products. An effort made to compile figures showing invested capital and production capacity was only partially successful.

No data have been secured to date for the industry in Canada. Therefore if the Committee on Statistics is continued for the coming year, this may be secured as well as possible additional data for the United States.

The statistics obtained to date are shown in Table I.

From the above statistics it will be observed that these two major groups of ceramic industries in the year 1929 in 2325 establishments, employed 213,414 people, paid $284,213,541 in payrolls, and produced or sold products valued at $709,375,526.

The Committee hopes that additional data may be obtained for other parts of the ceramic industry in the United States and for the entire industry in Canada, which it is thought will add 30% or more to the above figures. Furthermore, from the limited information available on invested capital it is believed that this figure would be more than twice the value of products in a good year like 1929, or about $1,418,751,052. By adding 30% for data not obtained, it is estimated that the entire industry has 3022 establishments, invested capital of $1,844,376,368, number of employees 277,436, annual payroll of $369,477,603, and value of products $922,188,184 per year.

The data presented show definitely that the ceramic industry ranks as one of the largest and most important in the country. Future work of the Committee could include comparison with the other major industries.

—THOMAS N. KURTZ, *Chairman*

January 30, 1935.

TABLE I

CERAMIC INDUSTRY IN THE UNITED STATES

Clay products industries, clay products other than pottery and nonclay refractories, pottery including porcelain ware, and sand-lime brick.

Year	No. of establishments	Wage earners (av. for year)	Wages	Salaried officers and employees	Salaries	Value of products
1929	2062	128745	$150,574,307	11273	$30,257,592	$405,556,966
1927	2162	137639	167,117,325	11373	29,881,085	430,505,181
1925	2248	139313	173,896,352	10514	21,844,339	444,808,445
1923	2287	139547	170,479,309			447,808,364
1921	2152	97217	109,081,494			278,546,848
1919	2754	104849	108,076,363			283,342,106
1914	3589	126887	71,573,748			172,864,051
			Glass			
1929	263	67527	$87,795,111	5869	$15,586,531	$303,818,560
1927	269	65825	81,352,734	5629	13,853,782	282,394,330
1925	310	69371	86,735,571	6076	13,364,569	295,959,424
1923	333	73335	89,897,948			309,353,411
1921	329	54748	68,224,248			213,471,309
1919	371	77520	87,526,625			261,884,080
1914	348	74502	48,655,819			123,085,019

REPORT OF CHAIRMAN OF ENAMEL DIVISION

Six committee reports, with the names of the corresponding committee chairmen, are listed on the Meeting Program of the Enamel Division, and these reports speak for themselves. In addition, other committees have also been active. For instance, the program itself constitutes the report of the Program Committee. And what a remarkable report it is! Chairman Danielson and his several co-workers deserve a big hand for their energetic and highly successful efforts, and the Division is also indebted to those who responded with such a wealth of papers.

The Executive Committee, consisting of the four councilors, the elected trustee, and the Secretary of the Division, have been called upon repeatedly for guidance in answering the unusually large number of questions, some of them quite important, which have arisen in connection with the management of the Division during the year. Their generous response and wise counsel deserve recognition.

The Editorial Committee, under Chairman Sweely, has proceeded quietly and efficiently to perform its difficult and exacting task.

Because it represents a new and promising undertaking, the Committee on Standard Methods of Analysis of Enamels and Enamel Materials, which functions as a branch of the Committee on Standardization of Tests, merits special mention. Chairman Schaal has made such an auspicious beginning in this work that it is evident we may look to the Committee for important contributions from time to time.

Although our benefactor, H. D. Carter, was unable to continue his services with the Data Committee, he has been engaged this year in putting in order for publication a supplement to the Landrum and Carter Bibliography on Enamels, which will extend through 1933. Assurances that the publication of this supplement will be underwritten were received through our General Secretary, and it is hoped we may soon be able to enjoy the fruits of these labors.

To all of these workers and to the various others who have given of their time and energy to the activities of the Division during the year, your Chairman wishes to extend sincere thanks, both personally and on behalf of the Division. Finally, recognition is due the individual members, whose support has made it possible and worth while to carry on. The continuation of such support will constitute an effective welcome to the incoming Chairman.

—W. N. HARRISON, *Chairman*, Enamel Division

ENAMEL DIVISION STANDARDS COMMITTEE REPORT

The Field of Action and the Objectives

It was the opinion of President McAfee and the General Standards Committee as well as that of the Chairman of the Enamel Division that the Committee should concentrate its efforts on tests of enameled products rather than on tests of materials.

Recent developments indicate that the present time is particularly desirable for a renaissance of interest in standardized test methods as applied to enameled products. The National Bureau of Standards is undertaking a comprehensive investigation on enamels and has agreed to undertake the development of standard test methods for enamels and enameled products. It was felt that the Committee might serve as a clearing house for a multiplicity of ideas on test procedures. Test methods either advanced for consideration or standing as tentative could be pushed. An observed tendency of leading technologists to get together on hitherto varying test specifications could be fostered. It seemed that the above material, diversely accumulated and impersonally presented, might be legitimately drawn upon by the Bureau of Standards in initiating their work, should they so desire.

There is but one reason for standardization of tests. It is to make vitreous enamel a more effective finish, by lowering waste in production and raising the quality of the finished product. One line of enamelware with poor adherence that passes onto the market unchallenged degrades an entire industry. The setting of standards establishes limits above which development work can be accepted as effective.

The rate at which suitable standard tests for each type of product are established and at least minimum performance requirements insisted upon will closely approximate the pace at which vitreous enamel as a finish will forge to the front.

Method of Attack

It did not seem particularly difficult to choose a starting point. Insofar as the enamel industry is concerned, tests of enameled products must involve one or more of the following localities (1) enamel surface, (2) body, (3) interface. A list of properties of enameled products was then drawn up, as follows:

(1)	Surface	acid resistance, opacity, gloss, color measurement, and resistance to abrasion
(2)	Body	crazing, chipping, resistance to impact, thermal shock, and flexure or tensile and compressive strength
(3)	Interface	adherence, reboiling, and coefficient of expansion or enamel "fit"

This list may not be complete but it was considered as offering quite enough material on which to work.

The above three subdivisions were distributed among the three members of the Committee, consisting of H. H. Holscher, C. H. Turner, and the writer. Since the Committee appointments were made, the work has gone forward. Progress has been made by means of questionnaires, personal letters, and reviews of published reports, affording an opportunity for comparison and correlation of existing tests.

The value of the final Committee Report will be largely limited by the extent of the coöperation received from members of the enamel industry. The Committee dares to hope that when the last reply has been analyzed and the last word of discussion voiced at the Buffalo Meeting, a contribution toward the well being of the industry will have been made.—DWIGHT G. BENNETT, *Chairman*

REFRACTORIES DIVISION COMMITTEE ON DATA REPORT

During the past year the Committee on Data of the Refractories Division has been engaged in an effort to collect and edit symbols, abbreviations, and definitions pertaining to refractory materials.

It has been the hope of the Chairman of the Division and the Committee that such a compilation would be useful to members in reporting original data and utilizing the data of others. Lack of uniformity of the symbology has caused no little concern in the past and it was at the request of several members that this work was started. It is hoped to present the material to the members of the Division for criticism and suggestions before putting it into final form.

The Committee has also prepared a short descriptive treatise on conventions to be observed in the statistical treatment of data. This, also, was undertaken by request. The Committee realizes that many of its members are familiar with statistics and statistical methods and the paramount object is to achieve a common method in the analysis of the data. It is, however, also hoped that this treatise may aid and guide those who are unfamiliar with the methods outlined.

The Committee is deeply indebted to Elliott P. Barrett, The Pennsylvania State College, for the work on the conventions of the statistical treatment of data. Dr. Barrett is exceptionally well informed on the subject and has done an excellent piece of work. The Committee takes this opportunity to thank him and to express appreciation to Mr. White, Dr. Sosman, Dr. Preston, and Mr. Phelps for their interest, suggestions, and constructive criticism of the work.—FRANCIS J. WILLIAMS, *Chairman*

Conventions to Be Observed in the Statistical Treatment of Data

(1) Introduction

For the purposes of interpretation and presentation of results obtained in routine testing and in research it is frequently necessary to make use of statistical methods. Although all statistical treatment of data is founded on the mathematical theory of probability, the professional statistician frequently makes use of a number of different measures of reliability the relation between which is not always clearly understood by the layman using statistics; or even if they are understood unnecessary effort is expended in converting from one method of treatment to another. It is our object to effect an economy of time and effort by arbitrarily choosing certain quantities for use as measures of reliability. Since the choice is arbitrary it is predicated primarily on simplicity of calculation. (In setting up these standards, the 1933 A.S.T.M. Manual on Presentation of Data has been freely used as a basis.)

(2) Types of Data

We distinguish two types of data. One is the type obtained in routine testing of a product to determine its constancy with reference to some property. For example, we may be interested in the transverse strength of brick which are being manufactured to specifications. The data in this case are obtained by proper sampling, followed by a standard test on each brick selected as a sample. It is obvious that to obtain this type of data our method of test must be such that the error in testing is less than the smallest significant variability in the property being measured.

The second type of data is that obtained when we desire to know some property of a particular specimen within certain limits. For example, we may wish to know the electrical resistance of a particular copper rod at a particular temperature. Here, instead of making one test on one piece and then passing on to another, we make many measurements in an effort to establish the value of the quantity as reliably as circumstances require.

(3) Measures of Variability

Insofar as the statistical treatment of data is concerned, it is of no significance with which of the two types we are dealing. In type one we are concerned with the *variability* of the *individual specimens*. In type two we are dealing with the *variability* of the *individual observations*. For the purpose of these standards, the numerical measure of the variation of individual quantity shall be the algebraic difference between the individual quantity and the arithmetic mean ($\overline{X}$),* *i.e.*, the "average" of the quantities. For the sake of brevity this measure shall be known simply as the difference (d). It is important to note that d is obtained by subtracting the average value from the individual value, *i.e.*,

$$d = X - \overline{X}$$

Where X = a particular value of the property being measured.

$\overline{X}$ is defined as $\Sigma \frac{X}{n}$.

The symbol sigma (Σ) means the sum of all terms of the indicated form.

The measure of the average variability of the individual members of a set of observations shall be the *standard deviation* (σ), *i.e.*, $\sigma = \sqrt{\Sigma d^2/n}$, where Σd^2 is the sum of the squares of the differences and n is the number of observations.

The measure of variability of the mean, $\overline{X}$, shall be the *mean error of the mean* (σ_m) $= \sigma/n^{1/2}$. It should be pointed out that this quantity indicates whether or not a sufficiently large number of observations has been made or a sufficiently large number of samples has been taken in any given case. For example, if out of 50,000 brick we take two lots of one hundred each, chosen at random from the entire 50,000, and if we test each lot separately for transverse strength and compute $\overline{X}$ for each lot, the result will not be the same in both cases, *i.e.*, $\overline{X}$ is itself a variable unless we test all 50,000 brick, which is impossible and obviously ridiculous. However, if we do test a hundred brick and compute $\overline{X}$ to be 1000 pounds per square inch, computation of σ_m will tell by how much, on the average, $\overline{X}$ for the first hundred will differ from $\overline{X}$ for any other hundred chosen at random. Furthermore, if σ_m for the first hundred is large relative to $\overline{X}$ we should probably de-

* Definitions and symbols for particular variables will be introduced as needed. They are grouped, for reference, in Table V, page 87.

cide to increase the number of brick tested in order to have a more reliable value for our average.

It should be noted that any of the above quantities may be expressed on a percentage basis by dividing them by $\bar{X}$ and multiplying by 100.

(4) *Recommended Form for Arithmetical Computation of Measures of Variability*

By way of illustration the arithmetical computation of $\bar{X}$, σ, and σ_m will be made for some data on the breaking strength of copper wire. In the tabulated computation, X is the breaking strength in pounds per square inch of specimens of 0.104 inch hard drawn copper wire. The arithmetical form of computation here given is applicable to any number of cases but it becomes very lengthy for large numbers of observations. When the number of observations is large, a method of computation based on the use of grouped frequency distributions may be used to shorten the computation work. This method will be described in section (5) on grouped frequency distributions.

X	d $(X - \Sigma X/n)$	d^2
578	+ 3	9
572	− 3	9
570	− 5	25
568	− 7	49
572	− 3	9
570	− 5	25
570	− 5	15
572	− 3	9
596	+21	441
584	+ 9	81
$\Sigma X = 5752$	$\Sigma d^2 =$	672

$\bar{X} = \Sigma X/n = 575$ $\quad \sigma = \sqrt{\Sigma d^2/n} = \sqrt{67.2} = \pm 8.2$ lb.

$\sigma_m = \sigma/n^{1/2} = 8.2/3.16 = \pm 2.6$ lb.

Also $\quad \%\sigma = (8.2/575)100 = \pm 1.4\%$

And $\quad \%\sigma_m = (2.6/575)100 = \pm 0.45\%$

Translated from mathematical symbols into words the results of these computations tell us that the breaking strength of the test specimens of this wire showed a standard deviation of ± 8.2 lb. or 1.4% from the average, and that the average was 575 lb. per sq. in.; and that the difference of the average for these ten specimens will "probably" not differ from that of any other ten, chosen at random, by more than ± 2.6 lb., or 0.45%.

It will be noted that the above statement contains an element of doubt of unspecified magnitude. Actually there is always attached a doubt to σ and σ_m. Because of this doubt, and also because $\bar{X}$, σ, and σ_m convey only a small amount of information when the number of observations or number of pieces tested is small compared to the total number of possible observations, or of pieces, it is necessary to obtain more information than they provide when using results of a relatively small number of tests as the basis for conclusions about a large number of cases. A method for obtaining this additional information will now be described

(5) *Grouped Frequency Distributions*

If X is a quantity measuring some property of a specimen of a material, and if upon measuring this property for n specimens the particular value, X_1, is obtained y_1 times, then y_1 is called the frequency (y) of X_1. In less formal language, the frequency of a particular value of a property being measured is the number of times that the value occurs. In order that measurements made at different times and on different numbers of samples may be directly compared it is better to use the relative frequency, y/n.

For the purpose of these standards the following three frequency measures are recognized: frequency (y), as defined above, relative frequency (y_r), and percentage frequency ($y°$), given by $y_r \times 100$; but in reports and publications only the percentage frequency shall be used. In reporting percentage frequency the total number of cases constituting the data shall always be given.

It is impractical to use the frequency of particular values for a number of reasons. Therefore, it is customary to choose groups of values lying between certain limits and to treat the group just as though it were a single valued quantity. Such a group is known as a *cell*. The size of the cell is determined by the boundaries chosen and is referred to as the *cell interval* (m). The units measuring m are the same as those used to measure the property which is being studied. It is usually desirable to make all the cell intervals equal, but there may occur instances in which it is preferable to choose smaller intervals for that portion of the range of values in which a majority of the observations lie.

The number of cells to be used must be chosen to yield the maximum amount of information with the data available. Experience is necessary in order to choose wisely. In general, between 13 and 20 cells are desirable, but if the experimental error is large in proportion to the total range of variability, and if the number of cases is not large (250 or more), no significant advantage will be gained from a large number of cells.

Before discussing the information derivable from grouped frequency distributions, the method of treatment will be illustrated by a simple example showing the application of the method to the following problem: A procedure had been devised for calculating the cone deformation temperatures (temperatures determined according to A.S.T.M. D271–33) of coal ashes from the ash analyses. There were available analyses and P.C.E. data for 69 samples of fire clay and it was desired to discover how closely the relationship for ashes held when applied to these data. The P.C.E. values were expressed as degrees F (at a definite rate of heating). The differences between observed and calculated values were then written down, a positive value being assigned to the differences when the calculated value was higher than the observed value. Taking into account the difficulty of assigning exact temperature equivalents to the P.C.E. values, and for experimental error, the data are probably not reliable, on the average, to higher than 50°F and extreme variations may be of the order of 100 or even 150°F. Consequently it is apparent that no useful end can be served by choosing the cell interval smaller than 50°F.

The first step is to group the differences into cells. This is conveniently done by making a table and making a mark opposite the proper cell for each difference. The computations are shown in Table I.

Table I shows that what has been done to obtain $y°$ for each cell is (1) to enter each difference in the cell to which it belongs; (2) to count the number of differences in each

TABLE I

GROUPED FREQUENCY DISTRIBUTION FOR DIFFERENCES BETWEEN OBSERVED AND CALCULATED VALUES

Cell No.	Range	y	y_r	$y°$
1	151 to 200	0	0.000	0.0
2	101 to 150	0	0.000	0.0
3	51 to 100	6	0.087	8.7
4	0 to 50	18	0.261	26.1
5	0 to − 50	27	0.391	39.1
6	− 51 to −100	14	0.203	20.3
7	−101 to −150	3	0.043	4.3
8	−151 to −200	1	0.015	1.5
	$n = \Sigma y =$	69	1.000	100.0

cell and enter the number under the heading y (*i.e.*, frequency); (3) to divide each item under y by the sum of all the cases, thus obtaining y_r; and (4) to multiply each value of y_r by 100 to obtain the corresponding value $y°$. In practice y_r and $y°$ would not both be calculated; either one or the other being used. It will be recalled that for publications $y°$ has been chosen as the standard.

Having obtained the data of Table I, it becomes necessary to interpret them correctly in order for them to be useful. From the values of $y°$ corresponding to each cell we can draw the following conclusions: (1) The cases distribute fairly symmetrically about cell 5. (2) There are more negative differences than positive differences. (3) Since the distribution is fairly symmetrical around a negative value and since the bulk of the differences falls within the 100° limit of error, the method by which the softening temperatures were calculated apparently gives good relative values but is, in general, in error by a constant amount. If, in addition, it is known that the same method of calculation, when applied to coal ashes, gave differences which distributed symmetrically about zero we can at once conclude that it is probable that the symmetrical distribution about a negative value is due to the differences in the standard method for determining P.C.E. and coal-ash softening temperatures.

It is frequently desirable to know what percentage of a set of results lie between certain limits. For this purpose a cumulative tabulation is desirable. In this illustrative problem, for example, we might wish to know what percentage of the cases lies within certain distances from zero without regard to the sign of the differences. The answer to this type of question is given in Table II.

TABLE II

CUMULATIVE FREQUENCY DISTRIBUTION FOR DIFFERENCES BETWEEN OBSERVED AND CALCULATED VALUES

Range	$y°$
Within 50°	65.2
Within 100°	94.2
Within 150°	98.5
Within 200°	100.0

(6) *Graphical Representation of Grouped Frequency Distributions*

Grouped frequency distributions may be graphically represented in a number of ways. For the purpose of these standards the type of plot known as the *frequency histogram* shall be used. Figure 1 shows a frequency histogram for the data of Table I. For the graphical representation of cumulative frequency, a plot such as Fig. 2 shall be used. Figure 2 is constructed from the data of Table II.

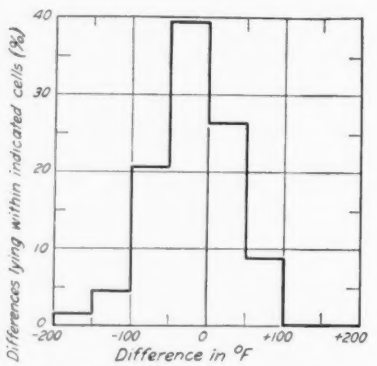


FIG. 1.—Frequency histogram.

In Fig. 3 are shown various types of frequency histograms in order to illustrate the sort of information which may be advantageously conveyed by means of such diagrams. In the figure it is assumed that the axis of abscissas represents values of the same property in all the diagrams, the variations in type of curve being due to differences in material, method of manufacture, etc. The ordinates represent percentages frequency ($y°$).

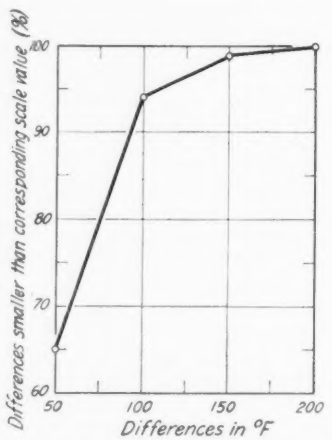


FIG. 2.—Cumulative frequency plot.

Parts A, B, and C of the figure serve to define the idea of position and spread. Before discussing part D, it is necessary to define the concept of modality. In a grouped frequency distribution, the cell into which the largest number (or largest percentage) of the cases falls is called the *mode* or *modal group*. In a normal frequency distribution the cases distribute symmetrically about the mode, *i.e.*, if a perpendicular is erected through the midpoint of the modal group, the two parts of the figure resulting from this operation are mirror images of each other. Asymmetrical distributions, such as those shown in the figure, produce various types of skewness.

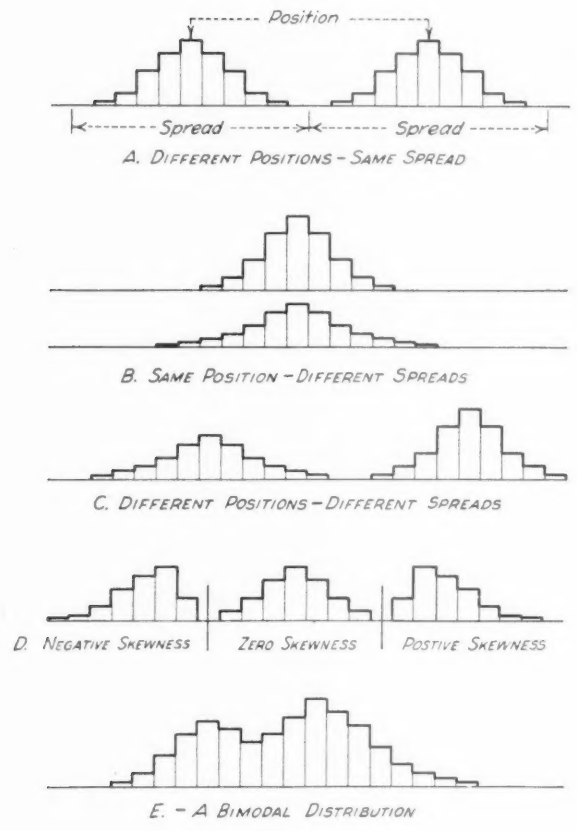


FIG. 3.

It is desirable to have a quantitative measure of skewness. To obtain such measure we shall define a new quantity, k, by the following equation:

$$k = \frac{\Sigma d^3}{n\sigma^3}$$

This quantity is a pure number. Since the numerator of the fraction is the sum of the cubes of the differences it will be positive when the sum of the cubes of the positive differences is greater than the sum of the cubes of the negative differences, negative when the converse is true, and zero when the two sums are equal. The quantity, $n\sigma^3$, is introduced as denominator of the fraction to keep the values of k small. Since the denominator is always positive the sign of k is entirely dependent upon the sign of Σd^3.

In Fig. 3, *E* illustrates a bimodal distribution. Such a distribution usually indicates that two different influences are affecting the variation of the observations of the property being measured. For example, if, in the figure, the axis of abscissas represents the transverse strength of samples of brick, we would be led to suppose that some of the brick from which our samples were taken had a different history than did others. They may have been made in different plants, from different materials, or by a different method of manufacture.

A histogram may exhibit more than two modes and may not exhibit a smooth slope from the mode toward the limits of variability, but, in general, such idiosyncrasies suggest some peculiarity of the data rather than of the materials under test. A see-sawing up and down from group to group may be due to the choice of a cell interval too narrow relative to the accuracy of measurement. By far the most common cause of irregularities is an attempt to apply this method of treatment to too few data. It must be remembered that the grouped frequency distribution only tells the literal truth about the data used to construct it. If we wish to generalize as to the variability to be anticipated in a particular property of some product we must select a large enough number of samples to give us a representative result. *Irregularities of the frequency histogram constitute an excellent qualitative check on the adequacy of the number of samples chosen for the test.* A quantitative measure is provided by the mean error of the mean, σ_m. If σ_m is large relative to the spread, it is obviously necessary to make more measurements before starting to generalize.

(7) *Shorter Form for the Calculation of the Measures of Variability*

It will be observed that, when the number of quantities is large, the method of calculation given in Section (4) becomes very laborious and time-consuming. Under these circumstances the computation can be simplified by means of a procedure based on the grouped frequency distribution. With this method an arbitrary origin, A, is chosen, and deviations from this origin are measured in cells instead of the actual units of the scale of measurement. The equation for calculating the average, $\bar{X}$, the standard deviation, σ, and the skewness, k, are given below. The quantities used in these equations are defined by Table III which also indicates the method of calculation. The data are taken from the 1933 A.S.T.M. Manual on Presentation of Data. The data are transverse strengths of 270 samples of brick; consequently, the cell midpoints and cell boundaries are given in pounds per square inch. The equations are

$$\bar{X} = A + m\frac{\Sigma yx}{n} \qquad (2)$$

$$\sigma = m\sqrt{\frac{\Sigma yx^2}{n} - \left(\frac{\Sigma yx}{n}\right)^2} \qquad (3)$$

$$k = \frac{\frac{\Sigma yx^3}{n} - 3\frac{(\Sigma yx)}{n}\frac{(\Sigma yx^2)}{n} + 2\left(\frac{\Sigma yx}{n}\right)^3}{\left[\frac{\Sigma yx^2}{n} - \left(\frac{\Sigma yx}{n}\right)^2\right]^{3/2}} \qquad (4)$$

It should be pointed out that results obtained by this shorter method are not exact because the equations are derived on the assumption that all the observations in any one cell have a value equal to that of the cell midpoint. However, when the number of observations is large, the error in computation is not serious. This is shown in Table IV which compares the values $\bar{X}$ and σ for these data when computed by the exact method of Section (4) and by this shorter method.

TABLE III

FORM FOR COMPUTING $\bar{X}$, σ, AND k BY THE SHORT METHOD

Cell No.	Cell mid-point	Cell boundary	Deviation in cells from A (x)	Observed frequency (y)	yx	yx^2	yx^3	Relative frequency
		225						
0	300	375	0	1	0	0	0	0.4
1	450	525	1	1	1	1	1	0.4
2	600	675	2	6	12	48	48	2.2
3	750	825	3	38	114	1026	1026	14.1
4	900	975	4	80	320	5120	5120	29.6
5	1050	1125	5	83	415	10375	10375	30.7
6	1200	1275	6	39	234	8424	8424	14.5
7	1350	1425	7	17	119	5831	5831	6.3
8	1500	1575	8	2	16	1024	1024	0.7
9	1650	1725	9	2	18	1458	1458	0.7
10	1800	1875	10	0	0	0	0	0.0
11	1950	2025	11	1	11	1331	1331	0.4
				Σy	Σyx	Σyx^2	Σyx^3	
				270	1260	6370	34638	100.0

A = midpoint of cell No. 0 = 300
m = number of units per cell = 150
$n = \Sigma y$ = number of observations = 270

Computation factors for $\bar{X}$ and σ

$$(a) = \frac{\Sigma yx}{\Sigma y} = \frac{1260}{270} = 4.666667$$

$$(b) = \frac{\Sigma yx^2}{\Sigma y} = \frac{6370}{270} = 23.592593$$

$$(c) = (a)^2 = 21.777781$$

$$(d) = (b) - (c) = 1.814812$$

$$(e) = (\sqrt{(d)})^3 = (1.347150)^3 = 2.444825$$

Computation factors for k

$$(f) = \frac{\Sigma yx^3}{\Sigma y} = \frac{34638}{270} = 128.288888$$

$$(g) = 2(a)^3 = 203.259303$$

$$(h) = (f) - (g) = 331.548191$$

$$(i) = 3(a)(b) = 330.296325$$

$$(j) = (h) - (i) = 1.251866$$

$$\bar{X} = A + m(a) = 300 + 150(4.666667) = 1000.0$$

$$\sigma = m\sqrt{(d)} = 150(1.347150) = 202.07$$

$$k = \frac{(j)}{(e)} = \frac{1.251866}{2.444825} = 0.512$$

TABLE IV

	Exact value	Value found by short method
Average ($\bar{X}$)	999.8	1000.0
Standard deviation (σ)	201.51	202.7

(8) Standards for Presentation of Data

The following material, which is taken from the 1933 A.S.T.M. Manual on Presentation of Data, shall constitute the standards for the presentation of data in reports and publications:

Presentation of Relevant Information

"44. *Introduction.*—Empirical knowledge is not contained in the observed data alone, rather it arises from interpretation—an act of thought. Interpretation consists in testing hypotheses based on prior knowledge. Data constitute but a part of the information used in interpretation—the judgments that are made depend as well on other pertinent information, much of which may be of a qualitative rather than of a quantitative nature.

If the data are to furnish a rational basis of prediction and generalization, they must be obtained under controlled conditions and must be free from constant errors of measurement. Mere presentation does not alter the goodness or poorness of data. The usefulness of good data may, however, be enhanced by the manner in which they are presented.

"45. *Relevant Information.*—Presented data should be accompanied by available relevant information, particularly information on precisely the field within which the measurements are supposed to hold and the conditions under which they were made and evidence that the data are good. Among the specific things that may be presented with A.S.T.M. data to assist others in interpreting them or to build up confidence in the interpretation made by an author are:

1. The kind, grade, and character of material or product tested.
2. The mode and conditions of production, if this has a bearing on the feature under inquiry.
3. The method of selecting the sample; steps taken to insure its randomness or representativeness.
4. The specific method of test; if an A.S.T.M. or other standard test, so state, together with any modifications of procedure.
5. The specific conditions of test, particularly the regulation of factors that are known to have an influence on the feature under inquiry.
6. The precautions or steps taken to eliminate systematic or constant errors of observation.
7. The difficulties encountered and eliminated during the investigation.
8. Information regarding parallel but independent paths of approach to the end results.
9. Evidence that the data were obtained under controlled conditions; the results of statistical tests made to support belief in the constancy of conditions, in respect to the physical tests made and/or the material tested.

Much of this information may be qualitative in character, some may even be vague, yet without it the interpretation of the data and the conclusions reached may be misleading or of little value to others.

"46. *Evidence of Control.*—One of the fundamental requirements of good data is that they should be obtained under controlled conditions. The interpretation of the observed results of an investigation depends on whether or not there is justification for believing that the conditions were controlled.

If the data are numerous and statistical tests for control are made, evidence of control may be presented by giving the results of these tests. Such quantitative evidence greatly strengthens indicative arguments. In any case, it is important to indicate clearly just what precautions were taken to control the essential conditions. Without tangible evidence of this character, the reader's degree of rational belief in the results presented will depend on his faith in the ability of the investigator to eliminate all causes of lack of constancy.

Conclusions

"47. "*Recommendations for Presentation of Data.*—Given a set of n observations of a single variable obtained under the same essential conditions.

1. Present as a minimum, the average, the standard deviation, and the number of observations.
2. If the number of observations is large and if it is desired to give information regarding the shape of the distribution, present also the value of the skewness, k, or present a grouped frequency distribution.
3. If the data were not obtained under controlled conditions and it is desired to give information regarding the effect of assignable causes, present the values of the maximum and minimum observations in addition to the average, the standard deviation and the number of observations.
4. Always state the number of observations taken.
5. Present as much evidence as possible that the data were obtained under controlled conditions.
6. Present relevant information on precisely (*a*) the field within which the measurements are supposed to hold and (*b*) the conditions under which they were made."

(9) *Definitions and Symbology*

Table V defines the quantities and symbols used in this report. These definitions and symbols shall be standard for all reports and publications.

TABLE V

Quantity	Symbol	Definition
Average	$\overline{X}$	Arithmetic mean of a set of observations, *i.e.*, $\Sigma X/n$
Difference	d	Algebraic difference between, s, single observation, X, of a set of observations and the average of the set, *i.e.*, $X - \overline{X}$
Sigma	Σ	Mathematical symbol meaning "the sum of" all terms of the form indicated, *e.g.*, Σd^2 means the sum of the squares of the difference
Number	n	Total number of observations in any set
Standard deviation*	σ	$\sqrt{\Sigma d^2/n}$
Mean error of the mean*	σ_m	$\sigma/n^{1/2}$
Frequency	y	Number of times that a result of magnitude X occurs in a set of observations. In a grouped frequency distribution the number of results in a cell of interval m and midpoint X
Relative frequency	y_r	y/n. Note that $n = \Sigma y$
Percentage frequency	y°	$y_r \times 100$
Group frequency distribution		An arrangement of a set of observations which shows the frequency of occurrence of particular results in ordered classes
Cell, cell interval	m	The interval, along the scale of measurement, of each ordered class
Mode, modal group		In a grouped frequency distribution a cell for which y is a maximum
Skewness	k	$\Sigma d^3/n\sigma^3$

* These quantities may be expressed on a percentage basis by dividing by $\overline{X}$ and multiplying by 100.

THE PENNSYLVANIA STATE COLLEGE
STATE COLLEGE, PA.

REFRACTORIES DIVISION EDITORIAL COMMITTEE REPORT FOR 1934

The following is the report to date:

	Feb. 1934 Meeting	April 1934 Meeting*	New papers	Total
Papers reviewed once	19	6	14	39
" " twice	3	0	1	4
" recommended for publication in *Journal*	15	4	9	28
Papers recommended for publication in *Bulletin*	0	0	2	2
Papers published in *Journal*	12	1	2	15
" " " *Bulletin*	1**	1†	0	2
" " elsewhere	2‡	0	0	2
Papers in hands of Committee	1	0	1	2
Papers rejected	1	2	1	4
Papers returned to authors for correction and not returned to Committee	1	0	1	2
Papers not received to date	5	0	0	5
Papers awaiting publication	3	2	9	14

* Joint Meeting with Electrochemical Society.
** Referred to special committee.
† At Editor's option.
‡ One without review of Committee.

Several letters were written to the Editor and to the Chairman of the General Society Publications Committee concerning adherence to the By-Laws of the Society and of the Refractories Division regarding publication of papers. There was also some correspondence on papers returned for corrections in which the authors were not in agreement with the rulings of the Committee.

—H. E. WHITE, *Chairman*

REFRACTORIES DIVISION RESEARCH COMMITTEE REPORT

During 1934, the Research Committee has followed the plan used in previous years. Our object has been to appraise, to the best of our ability, what subject matter would at present be helpful to widespread understanding of the fundamental properties of refractories and refractory materials, and then to suggest development of these subjects to persons whom we believe are interested in developing them. The method, we hope, is fruitful to a degree.

During the present year we have made the following suggestions:

(1) Research on used refractories.

(2) Symposium on "Rate of Reaction" for the Refractories Divisions 1935 meeting.

(3) Subject for research: "The Solution of Silica Particles in Clay upon Heating."

(4) Idealized geologic column of the refractory clays of the United States. This work is under way.

(5) A critical survey of instruments for research on refractories; (*a*) description and manner of use of available equipment; (*b*) needed equipment that is not yet available.

It is tentatively arranged for an organization to undertake this work.

(6) A rational method of predicting the usefulness and behavior of refractory clays, based on easily determinable fundamental properties of clay substance.

(7) Nature of the origin of refractory clays, and how this synchronizes with (6).

Letters and conversations have evolved during the year in connection with each of the above topics.—*Research Committee, Refractories Division:* DONALD W. ROSS, *Chairman;* R. A. HEINDL, F. A. HARVEY, L. J. TROSTEL, STUART M. PHELPS, GORDON B. WILKES.

REFRACTORIES DIVISION STANDARDS COMMITTEE REPORT

(A) Standardization of Tests

Following the discussion of the activities of this Committee at the Cincinnati meeting, it was decided to discontinue the policy of the Committee originating new tests and improving old tests for refractories and refractory materials for the C-8 Committee of A.S.T.M. The Committee now refers suggested changes to the Committee on Tests and Specifications of C-8 Committee of A.S.T.M. The following suggestions are given as to the duties of this Committee which should be written into the By-Laws of the Refractories Division:

(1) The Committee should serve as a contact between Refractories Division of the American Ceramic Society and C-8 Committee of A.S.T.M. for the purpose of improving present tests on refractory materials and in developing new ones.

(2) The Committee should present to the Refractories Division, prior to the publication of a Book of Standards by the American Ceramic Society, a complete list of A.S.T.M. standards and tentative standard tests on refractory materials.

(3) The Committee should be represented on the General Standards Committee of the American Ceramic Society in order to approve for publication standards on refractory materials which are approved by the Refractories Division.—R. S. BRADLEY, *Chairman*

(B) Standardization of Products

This Committee has coöperated with the General Committee on Standards of the Society in the matter of writing definitions for certain terms pertaining to refractories.

The Committee is also investigating the matter of the advisability of coöperation between the Refractories Division of the American Ceramic Society and the International Standards Association, Committee 33 on Refractories. This matter is being handled jointly with a special Subcommittee of Committee C-8 on Refractories of the A.S.T.M.—E. H. VAN SCHOICK, *Chairman*

REFRACTORIES DIVISION COMMITTEE ON STATISTICS REPORT

Available information, representing the scope of the refractories industry, in respect to number of companies, invested capital, annual sales, and number of employees, is given in the tabulation below. This information was supplied through the courtesy of the American Refractories Institute. No information is available in respect to the annual payroll.

	1928	1930	1932	1933	1934
Number of companies					322
Invested capital in millions of dollars	150	150	150	150	150
Annual sales in millions of dollars	52	54	13	33	
Number of employees	16,000	18,200	7,900	20,000	20,000

—L. C. HEWITT, *Chairman*

FINANCIAL AND MEMBERSHIP REPORTS FOR 1934

AUDIT REPORT OF THE AMERICAN CERAMIC SOCIETY

Statement of Assets and Liabilities as of December 31, 1934

ASSETS		
Cash in Bank (general account)	$4,390.28	
Cash in Revolving Fund	300.00	
Petty Cash in Office	5.00	$ 4,695.28
Liberty Bonds (par $3200)	3,281.00	
U. S. Treasury Bonds (par $400)	409.16	
Savings Account (Buckeye Bldg. and Loan Co.)	920.24	4,610.40
Accounts Receivable	1,591.27	
Accrued Interest	16.21	1,607.48
Inventories		
Journals	1,315.00	
Transactions	384.00	
Enamel Bibliographies	126.45	1,825.45
Office Equipment (less depreciation)		1,607.82
TOTAL ASSETS		14,346.43
LIABILITIES		
Accounts Payable	$2,127.79	
Fellow Dues	1,735.97	$ 3,863.76

Deferred Income (prepaid)		Total Deferred Income	8,474.13
Corporation Dues	2,044.00		
Personal Dues	5,147.43	Total Liabilities (including Deferred Income)	12,337.89
	7,191.43	SURPLUS (Assets over Liabilities)	2,008.54
Prepaid *Journals* (subscriptions)	1,282.70	TOTAL LIABILITIES AND SURPLUS	14,346.43

Comparative Income and Expense Statement—Years 1932, 1933, 1934

INCOME	1932	1933	1934
Dues, Corporation	$ 4,672.91	$ 3,786.73	$ 4,093.30
Dues, Personal	14,953.89	10,731.63	11,666.89
Divisions	1,501.73	919.32	182.87
	21,128.53	15,437.68	15,943.06
Journals (current year)	4,401.20	3,657.87	3,260.15
Journals (previous years, net)	110.09	283.38	358.05
	4,511.29	3,941.25	3,618.20
Advertising (net)	7,929.78	6,522.82	7,424.95
Miscellaneous	181.11	72.46	72.25
Fellow Account		700.00	
Reprints (net)			464.83
Annual Meeting		125.21	
Contributions		565.00	126.32
Interest	505.01	448.84	246.27
	8,615.90	8,434.33	8,334.62
TOTAL INCOME	34,255.72	27,813.26	27,895.88

EXPENSES	1932	1933	1934
Cost of Publication	13,570.80	13,175.69	12,475.81
Abstracts	1,331.39	788.30	690.20
Reprints (net)	126.26	87.07	
Editor's Office Expense	1,144.91	868.44	935.18
	16,173.36	14,919.50	14,101.19
Salaries	12,313.25	11,420.01	12,598.13
President's Office Expense	31.16	2.40	
Secretary's Office Expense	1,052.71	1,113.45	1,535.08
Postage	982.24	985.41	1,294.71
Office Rent	970.00	960.00	960.00
Miscellaneous	234.44	381.77	25.39
Traveling	204.23		
Annual Meeting	873.24		160.00
Depreciation on Furniture and Fixtures	213.00	198.50	178.64
Bad Accounts	128.98	82.09	100.77
	17,003.25	15,143.63	16,852.72
TOTAL EXPENSES	33,176.61	30,063.13	30,953.91
Gain or (Loss)	1,079.11	(2,249.87)	(3,058.03)

THEY MUST PAY TO GET ON BOARD GOOD SHIP CERAMICS SAILING PROGRESS RIVER

	Paid Members		Total	Resigned	Unpaid	New Members	Subscribers Deferred Payment and Current Sales	Total Circulation
	Personal	Corporation						
Dec. 31, 1934	1239	167	1406			181		1988
Jan. 31, 1935	708	127	835	20	650	28	516	1996

WHY THEY HAVE TO PAY

Services rendered involve a cost that must be met.

The 1934 Annual Financial Statement here given shows that in spite of the economies realized from the format of the publications and by adhering to the budget we had to use $2249.87 of the reserves.

There is only $2008.54 left of the $11,000.00 reserves which the Society had at the beginning of the depression.

The Board of Trustees and the Publications Committee visioned this situation in 1933. They put *The Bulletin* in its new format and separated it from the *Journal* and *Ceramic Abstracts* to *decrease* publication costs and at the same time to *increase* its effectiveness. Beginning with January, 1934, the *Journal* and *Ceramic Abstracts* were issued in the larger format. Their expectations of decreased cost and increased effectiveness were realized. Alarming though the situation is, as disclosed by the 1934 financial statement, there are evidences that this Society will render more effective and abundant services from

now on. These evidences are (1) more effective committee work, (2) increased interest by Local Sections and Student Branches, (3) more vigor of Division officers and committees, (4) a steady growth in membership, and (5) larger support by corporations.

Corning Glass Works

Corning Glass Works increased its corporation dues to $100.00 and increased its membership of personal members to a total of 22.

Hartford Empire Company

Hartford Empire increased its corporation dues to $75.00 without decreasing the number of personal members in its organization.

North American Refractories Company

North American Refractories Company increased its corporation dues to $50.00 without decreasing the number of personal members employed.

A. P. Green Fire Brick Company

The A. P. Green Fire Brick Company increased the number of personal members in its employ to a total of 16 paid members, with others in prospect.

Norton Company

The following letter has been received from L. E. Saunders, Manager of the Research and Abrasive Plants of Norton Company, Worcester, Mass.

It has been decided by our Directors to increase our membership fee in the American Ceramic Society from $25 to $50 per year.

As we have already paid $25 for the year 1935, will you kindly send us a bill for $25 additional so that our books may be more easily kept?

You may consider this our permanent membership fee in the future.

Many Others Want Invitation to Join

Mr. Paxton, of the Mississippi Glass Company, Washington, Pa., who recently became a member of the Society writes the Editor as follows:

I was pleased indeed to receive your letter of January 23, notifying me of my election to membership in the American Ceramic Society. The fact that I have long wanted to become a member of the Society increases my appreciation of my recent election.

There are many other persons waiting for a personal invitation to join us. How many will you invite?

With full confidence that the turn has been made toward meeting the expenses of this effective coöperation by current income, it must be realized that our members have "just begun to fight." A lot of earnest and continuous effort will have to be made by each member of the Society if the present scale of rendered services is to be maintained. The Society's 1935 income must fully meet the 1935 expenses.

ROSTER CHANGES DURING JANUARY

PERSONAL

Atkins, K. Dean, Moweaqua, Ill. (Martinsville, Ill.)
Blume, Arthur J., Chatsworth, N. J. (Haddonfield, N. J.)
Croskey, Carl D., Box 431, Rutgers University, New Brunswick, N. J. (Zanesville, Ohio.)
Dietrich, Waldemar F., 229 E. Bellevue Ave., San Mateo, Calif. (San Francisco, Calif.)
Hopkins, Robert W., 108 W. Morrell St., Streator, Ill. (Portsmouth, Ohio.)
Kleerup, Alex, 40–17 172nd St., Flushing, N. Y. (Chicago, Ill.)
McKeown, Thomas H., P. O. Box E, Metuchen, N. J. (Perth Amboy, N. J.)
McSwiney, Daniel J., Box 26151, Fort Lauderdale, Fla. (Columbus, Ohio.)
Merwin, Byron W., 307 Narrow Way, Benton, Ark. (Ames, Iowa.)
Swain, Stephen M., 1740 N. Taylor Rd., E. Cleveland, Ohio. (Saltsburg, Pa.)
Trees, Jack E., 1582 Myrtle Ave., Columbus, Ohio. (Anderson, Ind.)
Whitmer, J. D., Sparta Ceramic Co., East Sparta, Ohio. (Cambridge-Wheatley Co., Cincinnati, Ohio.)

NEW MEMBERS

PERSONAL

Barnes, Samuel L., 320 Sheridan Ave., New Castle, Pa.; Factory Manager, Universal Sanitary Mfg. Co.
Boone, Carl Hardaway, B. Mifflin Hood Tile Co., Norwood, N. C.; President.
Brown, J. Harrison, 1011 S. Olive, Mexico, Mo.; General Manager, A. P. Green Fire Brick Co.
Bryant, Gordon L., 5600 W. Taylor St., Chicago, Ill.; Edison General Electric Appliance Co.
Dodd, Arthur E., 8 Prior Street, Port Talbot, Glamorgan, England; Refractories Chemist, British Iron & Steel Co.
Earl, J. Alfred, 3017 Zephyr Ave., Pittsburgh (4), Pa.; Vitro Mfg. Co.
Fels, C. G., Atlantic Terra Cotta Co., Perth Amboy, N. J.; Chief Chemist.
Gill, LaVerne N., Pacific Pottery Works, Box I, Richmond, Calif.; Standard Sanitary Mfg. Co.
Green, Allen P., Jr., 1105 S. Jefferson, Mexico, Mo.; Sales Engineer, A. P. Green Fire Brick Co.
Hannah, E. R., 528 W. Robinson St., Mexico, Mo.; A. P. Green Fire Brick Co.
Hazen, E. J., Ford City, Pa.; Assistant Supt., Pittsburgh Plate Glass Co.
Hedquist, Alfred J., 219 West Ave., Elyria, Ohio; Ceramic Color Laboratory, Harshaw Chemical Co.
Henry, Edward C., 31 Mine St., New Brunswick, N. J.; Instructor and Research Fellow, Dept. of Ceramics, Rutgers University.
Hunt, Ercel B., 1209 E. Promonade, Mexico, Mo.; Supt. of Insulating Plant, A. P. Green Fire Brick Co.
Kay, William T., West Boulevard House, Mexico, Mo.; Ceramic Engineer, A. P. Green Fire Brick Co.
Lutton, Xavier W., 4 W. Laurel Ave., New Castle, Pa.; Production Mgr., Universal Sanitary Mfg. Co.
Mautz, Paul H., Route 7, Marion, Ohio; Engineering Experiment Sta., Columbus, Ohio.
McDonald, E. F., Ingram-Richardson Mfg. Co., Beaver Falls, Pa.
Miller, Lester J., 1015 S. Western Ave., Mexico, Mo.; General Supt., A. P. Green Fire Brick Co.
Paxton, E. W., 1 S. College St., Washington, Pa.; Manager, Mississippi Glass Co.
Payne, Harry C., 2818 Poplar St., Oakland, Calif.; Manager, Payne-Mahoney.
Pereny, Andrew, 842 N. Pearl St., Columbus, Ohio; Owner, Pereny Pottery.
Ricker, Richard W., Research Dept., Libbey-Owens-Ford Glass Co., Toledo, Ohio; Glass Technologist.
Sada, Camilo G., Troqueles y Esmaltes, P. O. Box 371, Monterrey, N. L., Mexico; Chemist.
Salisbury, William R., 315 Berkeley Dr., Syracuse, N. Y.; Onondaga Pottery Co.

Schroeder, Fred W., 326 Woodlawn Place, Mexico, Mo.; A. P. Green Fire Brick Co.
Stevens, J., 905 S. Clark, Mexico, Mo.; Sales Engineer, A. P. Green Fire Brick Co.
Sullivan, George R., 812 E. Love St., Mexico, Mo.; Plant Supt., A. P. Green Fire Brick Co.
Wall, Gertrude R., 1293 Hearst Ave., Berkeley, Calif.; Ceramist.

STUDENT

Kern, James E., University of Cincinnati, Cincinnati, Ohio.
McCloskey, Paul, Pennsylvania State College, State College, Pa.
Phillipson, Edward G., University of Saskatchewan, Saskatoon, Sask., Canada.
Robinson, Richard E., Pennsylvania State College, State College, Pa.
Ward, Charles J., University of Saskatchewan, Saskatoon, Sask., Canada.

Membership Workers' Record

PERSONAL

A. S. Adcock	1	Frank R. Porter	1
R. S. Bradley	9	Edward Schramm	1
R. B. Carothers	1	A. J. Strod	1
Willi M. Cohn	1	Office	5
Robert M. Curts	1		
C. E. Fulton	1	Total	29
A. M. Greaves-Walker	1		
Stanley Hind	1	STUDENT	
J. W. Hixson	1	Harold S. Nash	1
R. D. Humphreys	1	Nelson W. Taylor	2
George A. Loomis	1	W. G. Worcester	2
W. Keith McAfee	2		
		Total	5
		Grand Total	34

REPORTS FROM THE STUDENT BRANCHES OF THE SOCIETY

STUDENT BRANCH NEW YORK STATE COLLEGE OF CERAMICS TO ENTERTAIN OTHER STUDENT BRANCHES

The New York State College of Ceramics Student Branch of the American Ceramic Society will act as hosts to the members of the other Student Branches from the various schools attending the Annual Meeting in Buffalo. A Student Dinner will be held on Wednesday evening, February 20, which is complimentary to other visiting students.

Andrew J. Fedor, president of the New York Student Branch, has announced that the members of his organization offer their assistance to all students attending the Annual Meeting.

OHIO STATE UNIVERSITY STUDENT BRANCH

During the past year this Student Branch has held regular monthly meetings and listened to technical talks by the following persons:

(1) Geo. H. Duncombe, Jr., ceramic investigator for the sewer-pipe industry.
Subject: "Some Technical Problems in the Sewer Pipe Industry."
(2) Harry E. Nold, Chairman, O. S. U. Mine Engineering Dept., Columbus, Ohio.
Subject: "Clay Mining."
(3) A. L. Simison, ceramic engineer, Owens-Illinois Glass Company, Columbus, Ohio.
Subject: "The Ceramic Engineer in the Glass Industry."
(4) R. C. Purdy, General Secretary of the American Ceramic Society.
Subject: "The Philosophy of Compounding Ceramic Materials."
(5) Thomas Falknor, sales engineer, Edgar Plastic Kaolin Company.
Subject: "Mining Operations of the Edgar Plastic Kaolin Company."
(6) Ellsworth P. Ogden, superintendent, Standard Pyrometric Cone Company, Columbus, Ohio.
Subject: "Ceramic and Metallurgical Developments at Kuznetsk under the Russian Five-Year Plan."
(7) R. C. Purdy, General Secretary of the American Ceramic Society.
Subject: "Variety of Products Made from the Same Material."
(8) W. K. Carter, National Aluminate Corporation, Chicago, Ill.
Subject: "The Development of Sodium Aluminate in Correcting Faults in Ceramic Ware Manufacture."

Professor Watts also gave a series of short talks on "Ceramic Notables and Their Accomplishments."

Other activities of this Student Branch were participation in the annual Engineers Round-Up, Engineers Day, and All Engineers Banquet.

The Student Branch undertakes each year to carry out some special project which will add to the interest, and last year a special ash tray was modeled and molds made which are available to all students in the department who are interested.

The officers for the year 1934–35 are as follows:

President, Harold Reed
Vice-President, Philip Lieder
Secretary-Treasurer, Benjamin D. Jeffery
Senior Representative Engineers' Council, John A. Slyh
Junior Representative Engineers' Council, Lewis Bretz

—BENJAMIN D. JEFFERY, *Secretary*

UNIVERSITY OF NORTH CAROLINA, STATE COLLEGE BRANCH

Student Branch of the American Ceramic Society

The officers of the State College Branch of the University of North Carolina Student Branch of the American Ceramic Society are as follows:

President: W. R. McLain
Vice-President: R. B. Worth
Secretary: A. S. Lloyd
Treasurer: H. M. Hamburger
Representative, Engineers' Council: E. B. Smith
Faculty Adviser: A. F. Greaves-Walker

There are thirty-three members, twelve of whom are associate members and one faculty member. The meetings are held on the first Tuesday night of each month. During the past year there has been a good attendance at these meetings.

At the November meeting, fifteen new members were initiated into the Student Branch as associate members, who will become voting members in May of this year. After the initiation a "midnight" lunch was served in the ceramic laboratory.

At the other meetings during the year, lectures have been presented of particular interest to the ceramic engineer. The lectures were given by leading professors of the college and others who are authorities in their fields.

The associate members of the Student Branch, under the direction of R. L. Stone, teaching fellow, have been making plaster molds and casting ware to be given away as souvenirs at the Annual Engineers' Fair. This Fair is sponsored jointly by the Student Branch and by the other leading engineering societies of the college.

Ten members of this Student Branch will attend the Annual Meeting of the Society in Buffalo. The senior inspection trip will also be taken during the trip to Buffalo.

—W. R. McLain, *President*

PENN STATE STUDENT BRANCH

Our student branch of the American Ceramic Society began its activities with the beginning of the school year. At our first meeting in September, the following officers were elected:

President: Alfred B. Condon
Vice-President: Donald H. Wertz
Secretary-Treasurer: Richard A. Munro
Councilor: Nelson W. Taylor

On October 5 and 6 we were fortunate in having the Pittsburgh Local Section at State College, at which time very good papers were presented.

At the next meeting Dean Edward Steidle was our speaker. Dean Steidle, who toured the Mediterranean countries last summer, told about his trip, showing various articles that he had brought home with him. A social gathering followed the meeting.

It is with great anticipation that we await the Annual Meeting in Buffalo. The Juniors and Seniors expect to attend the Meeting and stop off at various plants on the way there and back.

Our Student Branch has twenty-three members, taking in several freshmen. Paul L. Smith from Illinois and Bennet Ellefson from Minnesota, both graduate students, came to Penn State this year.

—Alfred B. Condon, *President*

RUTGERS UNIVERSITY STUDENT BRANCH

The new officers, elected at the organization meeting in October, are as follows:

President: Walter H. Archbold, Jr.
Vice-President: Milo A. White, Jr.
Secretary: Robert Hamilton
Treasurer: Alfred P. Poles
Councilors: G. H. Brown and H. F. Vieweg

The Rutgers Student Branch of the American Ceramic Society seeks to acquaint its members with the scope and problems of the ceramic industries. With this in view, it has invited leaders of the industry, men thoroughly experienced in plant operation and those engaged in ceramic research, to talk at the Club meetings. Of the six meetings held during 1934, five featured guest speakers who talked on subjects of general and practical interest to the student ceramist.

The attendance at the meetings has averaged approximately 35, of whom about 20 were guests. The Club has found it advantageous to keep in contact with its alumni and has invited them to attend all meetings of interest.

—Walter H. Archbold, *President*

IOWA STATE COLLEGE STUDENT BRANCH

The Iowa State College Student Branch of the American Ceramic Society has a very successful year to report.

The membership of the Branch has been rather limited, averaging around fifteen members. Membership and activity in the organization is a curriculum requirement of all ceramic students above freshman rank.

The meetings are scheduled to be held at the hour set aside and held open for the college divisional meetings. All the members are free to attend them. Twenty-seven one-hour meetings were held during the past year.

Programs in the past have consisted of reports of many ceramic topics and were presented by the students. This practice has been abolished in favor of selecting a few major topics to be exhausted fully.

With this new idea in mind the abrasive industries, art, ceramics, ceramic fields for students, requirements of graduates by ceramic industries, and the ceramic publications have been the topics selected and reviewed. Students, faculty members, and one or two outside speakers carried on the discussion of these topics.

In May, on a special program, the Student Branch secured Professor Mortenson of the Dairy Industry Department to give a lecture on the background of the people who produce Copenhagen porcelain. Mr. Mortenson is a native of Denmark and collects Copenhagen porcelain as a hobby. This meeting was opened to all the departments on the campus.

Besides the regular meetings the Student Branch has held two social gatherings. The first such affair was a picnic held last spring. One of the members, who has had considerable experience as a lumber camp cook, prepared the meal which was based upon a quantity of steak and fried potatoes. During the Christmas season a special meeting was held which took the form of a Christmas party. Plans are being made for more meetings of this sort in the future.

As usual, the members sponsored and carried out the Ceramic Department's part in the college Veishea celebration held last spring. This in reality is an inspection period during which the public is given a chance to witness the activities and accomplishments of the college and the students.

The major features of Veishea are open houses of the departments and a parade of floats from the various depart-

ments. Since the floats must not cost over ten dollars, the ceramic department constructed large-scale models of sewer pipe, brick, drain and building tile, and a vase, all made of red builder's paper, laths, and hoops. Different students carried these models in the parade. Many laughs but no prizes resulted from their efforts.

The open house sponsored by the group proved more successful. Using "Buy America" as a theme, displays of fine tableware, cut glass, and similar ceramic ware were shown. Demonstrations on decorating ware, hand turning of pottery, plaster-mold work, slip casting, and machine forming of ware were shown. About 2000 persons viewed the show during the one evening that it was held.

During the past year the members of the Student Branch have been active in another project which has proved to be of both financial and educational value. The students, under the direction of Paul E. Cox, head of the department, have been making a set of seven terra cotta murals six by eight feet in size. These panels were designed and modeled as a PWA project by Christian Peterson, an Iowa artist; they are to be placed in a court of one of the buildings on the campus. This work is progressing quite well and the students working upon it are getting some first-hand knowledge of the trials of a terra cotta manufacturer.

Besides making possible the terra cotta project, the government has provided a chance for employment of two graduates from ceramics here on the campus. Earl Solomon is employed at the college by the Iowa State Planning Board and is carrying on studies concerning the present status and the possibilities of the ceramic industries of Iowa. Frank Hodgdon has been appointed to research assistantship at the engineering experiment station and at the present time is investigating the thermal history of Iowa clays. These two men, being located at the college, can contribute to the welfare of the students by lecturing at various times.

The Student Branch plans a program equal, if not larger, in scope for this coming year. Beginning in September, 1935, the freshman engineers will have two quarters of orientation during which time they are to decide upon the specific engineering curriculum they wish to follow. This practice will give the members of the Student Branch an opportunity to give these newcomers some ideas about ceramics and help them make their choice.

NECROLOGY

PASSING OF W. D. GATES

Another Charter Member of the American Ceramic Society has left us. We were greatly saddened by the loss of Charles Fergus Binns who died suddenly in November, 1934. In contrast to the splendid vigor of Dr. Binns, William Day Gates had been ailing for more than a year and since Christmas his condition was critical. He passed away at his home, Trail's End, Crystal Lake, Illinois, on January 28, 1935, and the funeral was held from his home on January 31.

W. D. Gates

Cullen W. Parmelee, Dean of the Fellows of the Society, attended the funeral, representing the Fellows and the American Ceramic Society.

W. D. Gates was born at Ashland, Ohio, in 1852. He was graduated from Wheaton College in 1875 and was admitted to the Illinois Bar in 1879. For a short while he practiced law in Chicago, but he soon became interested in clay and started the manufacture of terra cotta at Terra Cotta (McHenry County), Illinois, establishing the station there and originating the American Terra Cotta & Ceramic Company. This company was incorporated in 1887.

Mr. Gates was not only a Charter Member of the Society, but acted as temporary secretary at the time of its organization. He served as President of the Society in 1905. He was also President of the National Brick Manufacturers' Association in 1900 and of the National Terra Cotta Society in 1920.

DRAFT-PRESSURE FACTOR IN HEAT DISTRIBUTION*

By Ellis Lovejoy

The principles presented in this discussion on draft pressure are as follows:

(1) Heat distribution by convection in periodic downdraft kilns depends upon gas distribution and the latter depends upon available pressures.

(2) If the pressure is alike throughout the kiln ware room there will be no heat loss in consequence of volume changes. (Gases under compression give up heat; under expansion they absorb it.)

(3) The velocity and friction of the gases will be constant. Frictional contact and heat transfer from gas to ware will be alike throughout the ware mass.

(4) Heat absorption progressively downward by the ware affects gas volume, velocity, and friction but becomes nil at the finish when uni-

* Received, January 19, 1935.

form temperatures should prevail.

(5) Conservation of available pressure for use in the ware compartment is a prime factor in the uniformity of the final heat distribution.

Natural draft is induced by the available pressure at the furnace mouth. This pressure varies with the height of the stack, the temperature of the stack gases, and the specific gravities of the gases.

We may assume for the purpose of discussion that the available pressure at the furnace mouth of a periodic downdraft kiln is 0.40 ounce. It often does not exceed this. Let us further assume that the furnace friction (grates, fuel bed, door inlets, and bag) requires 30% of the available pressure and equals 0.12 ounce; the ware friction, 40%, equals 0.16 ounce; the under-flues and kiln damper, 20%, equals 0.08 ounce; and the stack, 10%, equals 0.04 ounce.

With these assumptions we have

$$\begin{aligned} &0.40 - 0.12 = 0.28 \text{ oz. pressure in kiln crown.} \\ &0.28 - 0.16 = 0.12 \text{ oz. pressure at kiln floor.} \\ &0.12 - 0.08 = 0.04 \text{ oz. pressure at kiln damper.} \\ &0.04 \text{ oz. for stack friction.} \end{aligned} \quad (1)$$

We are chiefly concerned with the first two, though the third is important since heat loss through the kiln floor depends upon the relative temperature above and below the floor.

The ratio of the above floor pressure to the crown pressure is $0.28/0.12 = 2.3$. The top and bottom temperatures will measurably vary in this ratio. A ratio of unity is 100% uniformity in gas (and heat) distribution.

Ideal firing of downdraft kilns attains the finishing temperature in the crown, holds it constant, and works it to the bottom without any drop. If the bottom and top ratio were unity we could do this. Since usually it is not unity the practice is to get a maximum limit temperature in the top which the ware will stand and work it to the bottom with such loss as happens, hoping to attain a finishing temperature in the bottom which is often difficult with a short firing range clay.

The heat losses in the ware compartment, other than the ware heat absorption, sensible and latent, which becomes zero at the finish, are as follows:

(*a*) Conduction through and radiation from the side walls which are negligible if the walls are properly insulated.

(*b*) Absorption of heat by the gases in consequence of their expansion through decrease in pressure.

(*c*) Velocity changes: an increase with expansion of the gases due to lower pressure *contra* a decrease with lower temperatures through reduced volume. The former likely exceeds the latter.

If a uniform pressure is developed or approximated, given time for ware-endothermic reactions progressively downward, practically the same temperature in the bottom of the kiln as that in the top can be attained. This applies to convected heat only. Radiant heat from incandescent soot and ash and from luminous flame other than incandescence is another problem, except that floating particles in the gases are affected in their heating effect by changes in gas volume, velocity, and friction due to changes in pressure.

Let us assume in the above that the gas velocity through the kiln is 4. It is commonly stated that gas friction varies as the square of the velocity; perhaps this is not wholly true, but for the moment we shall adopt this basis.

Let us reduce the velocity from 4 to 2 by damper control. The squares are 16 and 4; friction is reduced to one-fourth.

We now have

$$\begin{aligned} &0.40 - \frac{0.12}{4} = 0.37 \text{ oz. in kiln crown.} \\ &0.37 - \frac{0.16}{4} = 0.33 \text{ oz. at kiln floor.} \\ &0.33 - \frac{0.08}{4} = 0.31 \text{ oz. at kiln damper (which the damper itself should reduce to the stack requirement)} \end{aligned} \quad (2)$$

The bottom to top ratio is 1.1 instead of 2.3 as in the first instance and it is approximating unity which should give uniform pressure in the kiln room and uniform heat distribution.

The ratio of damper pressure to floor pressure is approximately unity and we shall have a hot under-floor to conserve the heat above the floor.

Considering the problem from the standpoint of friction: friction varies as the velocity instead of as the square, the frictions in the second illustration being reduced to one-half instead of one-fourth.

In this event, the crown pressure becomes $0.40 - 0.06 = 0.34$ and the floor pressure is $0.34 - 0.08 = 0.26$. The ratio is 1.3 instead of 2.3 as in the first instance and 1.1 in the second instance. (3)

It is obvious that the gas among the ware will be more uniformly distributed, more equably

compressed, and more uniform in temperature under a compression between pressures of 0.37 and 0.33 than between pressures of 0.28 and 0.12, the second and first illustrations, respectively.

We can develop these desirable pressures by using minimum draft velocities consistent with sufficient combustion to maintain the heat and, otherwise, by reducing frictions through the furnace (an open furnace door, for example) and through the ware (more open-setting).

An open furnace door does not necessarily involve excess air provided a balanced draft is maintained. In fact, with some back-fire, reducing conditions in the kiln room can be developed. Open furnace mouths are common in structural ware firing but not common enough. Less rare but very important is a balanced draft.

By balanced draft we mean just sufficient furnace inward air movement to avoid back-fire. The back-fire was used as a guide for proper draft. The dampers were lowered until there was back-fire at the furnace mouth; then it was raised to just clear this back-fire condition.

The furnace doors were so hung that they could not be fully closed and other provision was made for free admission of air—really for reduced furnace inlet friction.

One may ask, why not use forced draft and get any desired pressure; true, but we may easily lose in velocity friction more than we gain in increased pressure.

The forced-draft systems which have come to our attention, other than several automatic stoker operations, use hand-firing which involves opening the doors each time the fires are baited. We can not build up higher pressure in the furnace than the resistance to it. The furnace pressure is between two forces: (1) the atmospheric pressure at the top of the stack plus the resistance of stack, damper, flues, floor, ware, and bag up to the furnace and (2) the atmospheric pressure at the furnace mouth plus the furnace inlet friction.

With the furnace door open during firing the inlet resistance is slight and the furnace pressure can be but slightly higher than the atmospheric pressure without back-fire which we endeavor to avoid. The adjustment to avoid back-fire is an open damper to lessen the forward resistance. With the furnace doors closed and the damper still open, we may build up higher pressure in the furnace which is depleted by faster gas movement. The pressure ratio in the kiln room increases with corresponding drop in uniformity of heat distribution. Commonly the damper adjustment is to the open-door condition to avoid back-fire and not to the closed-door condition. To get the best results we should have the balanced draft throughout the heat-soaking period.

Under such conditions we shall have a decided gain with forced draft because of the higher available pressure.

In the first illustration (1), we estimated the furnace friction as 0.12. Under the same conditions, using forced draft, we can increase the furnace pressure to $0.40 + 0.12 = 0.52$, which, since the bag friction is slight, is practically the crown pressure. The floor (4) pressure becomes $0.52 - 0.16 = 0.36$. The ratio is 1.4 instead of 2.3 as in the first instance. Similarly forced draft will show gains in the other illustrations though in less degree.

In view of the above conclusion, a higher stack power or induced draft gives an advantage over low stack power in that there is higher available pressure at the furnace mouth. If this is conserved by control of the velocity, a higher pressure can be attained in the crown with relative gain in the pressure ratio. The gain, however, is slight if the available pressures are being used efficiently.

In conclusion, we express the opinion that in a large kiln closely set with brick we can not get uniform heat distribution without increasing the fuel consumption and the kiln turnover time, but we can approximate it and get a decided improvement in many present-day operations. We can more closely approximate it (perhaps attain it) in hollow ware and sagger settings which give much larger free space and corresponding reduction in friction.

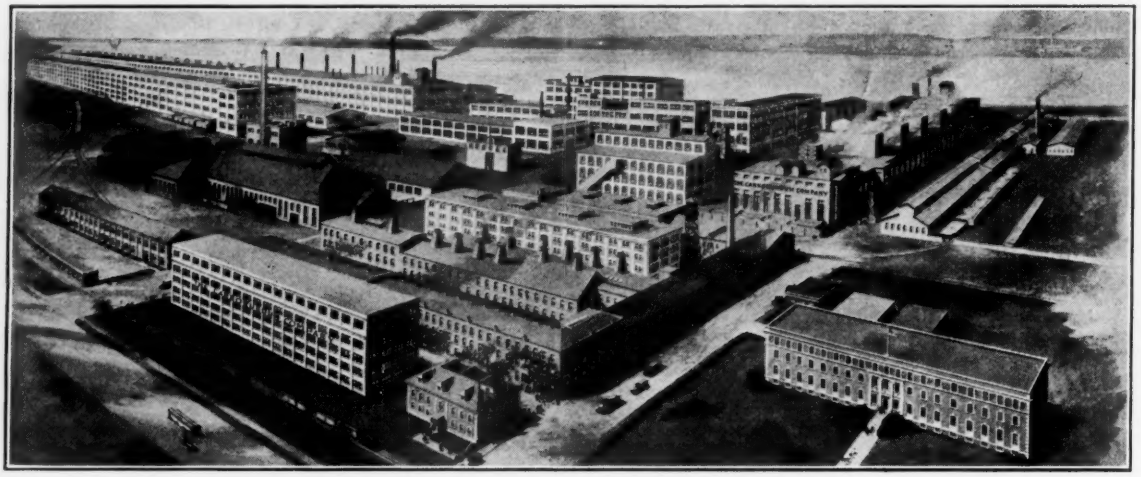
480 West Sixth Avenue
Columbus, Ohio

INFORMATION ON 1935 PLANT TRIPS

OUR VISIT TO THE CARBORUNDUM COMPANY

On Thursday, February 21, those attending the Annual Meeting of the Society in Buffalo, will journey to Niagara Falls to visit the plant of The Carborundum Company. As guests of this institution, the party will be shown through the electric furnace rooms and get a close-up of the manufacture of "Carborundum," one of the world's most useful abrasive and refractory products.

Arrangements will be made so that the whole furnace



The Carborundum Company Plant, Niagara Falls, N. Y.

process from beginning to end will be seen and studied. For instance, some of the furnaces will be shown being loaded with the charge of coke, sand, sawdust, and salt. Others will be shown loaded and ready to fire, in the process of firing, cooling, and being taken down for the removal of the finished product, the masses of the Carborundum Brand Silicon Carbide Crystal.

The furnaces used in the process are of the electric-resistance type. They are approximately 50 feet long, 8 feet wide, and each takes a charge of about 70,000 pounds of the crude mixture, which, during the furnace run of 36 hours, is subjected to a maximum temperature of 4000°F.

Each furnace uses 2000 h.p. or the equivalent of 72,000 h.p. hours during the 36-hour run, and is constructed of movable iron sidings lined with fire brick and has permanent ends or abutments through which the electrical energy is led from bus bars to cables through electrodes ten inches in diameter to a core formed through the center of the mixture of the crude materials. The electrical energy, in a sense, surges through this core, which is made up of particles of crushed graphite and coke, and the resistance set up makes possible the extremely high temperature at which Carborundum Brand Silicon Carbide is created.

NIAGARA FALLS POWER COMPANY

Visitors are welcome and the members of the Society are cordially invited to visit the Schoellkopf Station of The Niagara Falls Power Company any day from 9:00 A.M. to 5:00 P.M. The Station is located three blocks north of Falls Street at the canal basin.

Two methods are employed to bring water from the upper river to the Station: (1) an open canal and (2) a tunnel (32 feet in diameter) which runs 140 feet beneath the city. Each carries 10,000 cubic feet of water per second.

The water from the canal serves two forebays which feed thirteen 10,000 h.p. units and three 37,500 h.p. units. A separate forebay for the tunnel supplies water to three 70,000 h.p. turbines. All 19 units operate under a head of 213 feet.

The first of the 10,000 h.p. units was begun in 1906 but the remainder of the 13 units was not completed until 1913. During the World War the three 37,500 h.p. machines were installed, and shortly after the war the present capacity of the Station (452,500 h.p.) was achieved with the addition of three 70,000 h.p. units. Until recently these 70,000 h.p. units were the largest in the world driven by water. One of these machines is capable of supplying a city of 300,000 population with every domestic, commercial, and industrial demand for electricity.

The visiting ceramists will be escorted through the Station by well-informed guides. The inspection trip will take about thirty minutes.—W. A. ROOMSON, *Public Relations Department*

CHEVROLET MOTOR COMPANY

The ceramic guests will be permitted to see bare frames brought in onto an assembly line where the various attachments, such as axles, etc., are applied, and then the frame unit is removed from this line by one man (despite the fact that it weighs several hundred pounds) and placed on the main assembly line. From this point it grows through the various operations until it passes off the far end, a completed unit. The belt is the very latest type developed by the General Motors Company, having been installed only about four months ago.

The perfect synchronizing of parts is amazing. The painted parts, for example, are installed and as the chassis reaches the place where the bodies are lowered, the proper colored body is always there without any confusion whatsoever.

BETHLEHEM STEEL COMPANY, LACKAWANNA PLANT

This plant is one of the largest in the Bethlehem group.

The ceramists may see open-hearth furnaces tapped, steel poured from ladles into ingots, and the ingots rolled

into various structural shapes.

This plant is equipped to roll the largest I-beams manufactured.

An unusual feature of this plant is the extensive use of electricity. Every possible operation is electrified. The average plant requires a day and one-half to change the rolls in the rolling mill, a full day being required to adjust them. Here, a few screws and bolts are loosened, a crane picks up a complete roll assembly, moves it out, and comes back with another one which has been adjusted and ready for installation. It is dropped into place and is ready to resume operation in a short time.

Visitors will also see modern cargo handling equipment for unloading lake freighters, blast furnaces, and coke ovens.—F. A. LOBEE

CORNING GLASS WORKS TRIP

At the Corning plant of the Corning Glass Works the following operations may be seen:

(1) Drawing of tubing by hand process
  (*a*) Neon sign tubing.
  (*b*) Thermometer tubing.
(2) Blowing of bulbs by the hand process.
(3) Pressing of railway signal ware.
(4) Steuben art ware.
(5) Pyrex chemical ware by semi-automatic process.
(6) Pyrex blown ware.
(7) Automatic production of Pyrex baking ware.

At the Fall Brook plant the visitors will have an opportunity to see continuous automatic production of tubing for the electrical industries.

If time permits, the visitors may go to Wellsboro where the continuous high-speed automatic production of lamp and radio bulbs may be seen. This is probably the highest speed production of blown ware to be seen anywhere in the world.—J. C. HOSTETTER, *Development and Research Department*

GENERAL ELECTRIC COMPANY

Erie Works, Refrigerator Cabinet Division, Building 18

In this building are manufactured the cabinets for the General Electric all-steel electric refrigerators.

Here is centered the entire process of cabinet manufacture, starting with the punch presses where the flat steel sheets are formed, along through the welding, grinding, enameling, firing, cleaning, and assembling operations.

Large overhead conveyers or traveling stock rooms store and carry the finished parts, such as the outer casings, insulation, inner liners, doors, and legs, to the assembly conveyer lines. These parts are then assembled, carefully inspected, boxed, and conveyed to the warehouse or waiting freight cars.

The monitor top cabinets are packed without units, but the flat top models have the units (which are manufactured in the General Electric Fort Wayne Works) inspected and assembled in the cabinet completely ready for operation in the home.

Electric Locomotive Division, Building 10

All sizes of Diesel electric, gas electric, railway, industrial, and mining locomotives are manufactured in this building.

At present this division is busy with the Pennsylvania Railroad locomotives, including five P5A's and fourteen streamlined GGl's.

Several Diesel electric and mine locomotives are also under construction.

Air-brake equipments and air compressors for locomotives and street cars are also manufactured in this building.

Railway Control Equipments, Gallery, Building 10

In this gallery, control equipment is manufactured for electric railway, oil electric, Diesel electric, industrial and mine locomotives, and electric street cars and trolley coaches.

The equipment includes such parts as controllers, concontactors, line breakers, switches, relays, and interlocks. High-speed circuit breakers for substations and locomotive protection are also made here.

This shop, like others the ceramic guests will visit, is laid out for progressive manufacture of products.

Railway and Industrial Motors, Building 6

This building is composed of a five-story portion devoted to lightweight manufacture and a long one-story monitor top for heavy machining, assembling, and testing.

All sizes of motors for electric locomotives, street cars, self-propelled rail cars, trolley busses, gas electric busses, industrial battery trucks, cranes and hoists, electric shovels, etc., are made here together with generators for Diesel electric locomotives, self-propelled rail cars, gas electric buses, etc.

The motors range in size from 5 or 6 h.p. for battery trucks up to 1250 h.p. for electric locomotives. These latter are twin armature machines for the new Pennsylvania locomotives.

Miscellaneous

Attention is called to the Foundry, Building 22 where alloy and malleable iron castings are made; Building 5 which houses the tool room and apprentice department; Building 42 containing the pattern shop and the refrigerator unit warehouse; the personnel building, housing the personnel and employment departments, hospital and employees' store; the large power station with its self-supporting stack 300 feet above the ground; lawns, shrubbery, and the neat appearance of the plant in general.

ERIE PENNSYLVANIA TRIP
ERIE ENAMELING COMPANY

Ceramists visiting this enameling plant will be shown a modern jobbing shop with two box-type furnaces. The many special finishes being used on stove parts will prove

of interest to the visitors. Considerable unusual work in large signs is being done here.

This visit should prove interesting to all enamelists.

—G. B. FULTON

HAMMERMILL PAPER COMPANY

At this plant, guests will be shown papermaking from raw stock to the finished product. This company is one of the largest manufacturers of bond papers.

The pulp wood is brought from the Canadian forests to be chipped and ground with various chemicals. The processes involved will be shown as follows: The raw pulp wood is brought from storage to debarking process, to the digesters, and to the sulfite mill. This mass moves from the digesters to the bleaching room, then to a dewatering process, and into beaters. A liner is pressed in the paper, after which it is colored; thence it is brought to the finishing room, and after cutting, it is ready for shipment.—G. B. FULTON

SPECIAL ANNUAL MEETING BROAD PUBLICITY

Arrangements have been made for a group of men, prominent in the ceramic industry, to give short talks over several radio stations the week before the Buffalo Meeting of the American Ceramic Society. The speakers will talk on various phases of the ceramic industry and will also have something to say about the Buffalo Meeting. The speakers, stations, and times are as follows:

STATION	TIME	SPEAKER
WJAS, Pittsburgh	February 15, 5:00 to 5:15 P.M., E. S. T.	Alexander Silverman, University of Pittsburgh.
WHAM, Rochester	February 7, 4:45 to 4:55 P.M., E. S. T.	M. E. Holmes, N. Y. State College of Ceramics, Alfred, N. Y.
WFBL, Syracuse	February 5, 10:30 to 10:40 P.M., E.S.T.	L. E. Barringer, General Electric, Schenectady, N. Y.
WKBW, Buffalo	February 8, 8:05 to 8:15 P.M., E. S. T.	A. C. Dutton, Titanium Alloy Mfg. Co., Niagara Falls, N. Y.
WKRC, Cincinnati	February 6, 4:15 to 4:30 P.M., E. S. T.	Harold S. Nash, University of Cincinnati, Cincinnati, Ohio

The time for the broadcasting of these speeches has been most generously contributed by the management of the stations mentioned.

CHICAGO SECTION

"High-Temperature Insulating Refractories" was the subject of a meeting held by the Chicago Section of the American Ceramic Society in Chicago on January 17. An attendance of 60 was registered at the meeting.

Ralph K. Hursh of the Department of Ceramic Engineering, University of Illinois, gave the principal address, reviewing the subject in general and giving interesting information regarding the qualifications of these relatively new types of insulators. Professor Hursh was followed on the program by J. R. Parsons, research department, Chicago (Ill.) Fire Brick Co.; R. S. Moore, technical division, Harbison Walker Refractories Co., Pittsburgh, Pa.; Harry T. Bellamy, who developed the process used by A. P. Green Fire Brick Co.; and H. J. Shaner, Babcock & Wilcox Co., Chicago, Ill.

Mr. Parsons described the properties of "Pire," a plastic insulating refractory. Mr. Moore showed charts giving some results obtained with the use of refractory insulators, including a new type of lightweight silica brick developed by the Harbison-Walker Refractories Co. Mr. Bellamy and Mr. Shaner brought out some of the properties of insulating refractories, making suggestions as to the points which the user should bear in mind.

All speakers were agreed on one point, namely, that there is as yet little uniformity in the results obtained from conductivity measurements. Mr. Bellamy showed curves depicting a wide variation in the results obtained in three different laboratories for heat conductivity tests of the same material under presumably the same conditions. Mr. Shaner suggested that tests on different types of refractory material be made under similar conditions in the same laboratory in order that comparative data might be made available.

The meeting was presided over by G. G. Hanson, Consolidated Feldspar Corp., chairman.

—H. V. KAEPPEL, *Secretary*

KERAMOS ANNUAL MEETING

Keramos, professional ceramic engineering fraternity, is looking forward to the largest attendance of members in its history at the Annual Meeting of the American Ceramic Society in Buffalo, February 17 to 22. The headquarters of the fraternity will be at the Statler Hotel.

The annual dinner will be held on Tuesday evening, February 19, at 6:30, at which time the Executive Council will make its report on the accomplishments of the past year.

The Executive Council will hold a number of meetings during the week. Each of the active chapters promise to send a strong delegation to Buffalo.

The national officers of the fraternity are as follows:

President, F. L. Steinhoff, Editor, *Brick and Clay Record*, Chicago, Illinois
Vice-President, A. H. Fessler, A C Spark Plug Co., Flint, Michigan
Secretary, C. M. Dodd, Missouri School of Mines, Rolla, Missouri
Treasurer, S. R. Scholes, N. Y. State College of Ceramics, Alfred, New York
Historian, A. F. Greaves-Walker, University of North Carolina, Raleigh, N. C.

OHIO STATE UNIVERSITY ALUMNI DINNER

The annual dinner-meeting of the Ohio State University Alumni will be held on Monday evening, February 18, 6:30 P.M., at Lorenzo's Restaurant, located at 386 Pearl Street. This restaurant is only a short distance from the Hotel Statler.

The price for the dinner will be $1.00 per person and tickets can be obtained at the Registration Desk at the Society Headquarters in the Hotel Statler.

—A. L. DONNENWIRTH

OLD GLASS COLLECTION

The George Willard Benson Collection of over 900 pieces of old American glass on exhibit in the Museum of the Buffalo Historical Society evolved much as did the making of glass in this country. It may be classified in three distinct groups, bottles, tableware, and ornamental glass.

Bottles

The Collection contains a large number of whiskey flasks of varied designs made during the first half of the 19th Century. Among them are flasks made by most of the notable glassmakers of that period, Kensington, Whiteney Brothers, Huffsey & Company, and at the factories in Philadelphia, Baltimore, Pitkin (Conn.), Keene (N. H.), Fisherville (Pa.), Lancaster (N. Y.), and many others of the earlier and later glassworks. There are historical flasks which bear the portraits of early heroes and statesmen: Washington (several distinct designs), Lafayette, Franklin, Jackson, Taylor, Kossuth, Jennie Lind, and others. Many of these flasks commemorate historic events, and others bear Masonic emblems, etc., a favorite being the American eagle in various designs.

Tableware

The larger part of the collection consists of tableware.

There are a few pieces made by Stiegel and by some of the early Jersey glassmakers, and a great variety of all sorts of tableware from the factories of Sandwich and Cambridge (Mass.), and various glassworks in Pennsylvania, New Hampshire, and New York.

The great variety of pressed-glass salt cellars made during the 19th Century is interesting. The collection of over one hundred is of varied designs and is displayed with a few old-time bread plates of which many patterns were made.

The collection of cup-plates offers a great variety of designs for comparison. They have a distinctive charm and possess historic value. Most of the cup-plates were made at Sandwich (Mass.) but probably many were made in other glass factories.

The early Sandwich and other clear glass tableware are of special interest because most of the pieces were made between 1825 and 1835, the period of brilliant lacy glass.

There is a variety of clear and colored tableware of a later period, made at Sandwich and other glassworks. Many of these pieces have etched designs and others have molded patterns representing flowers, fruit, birds, beasts, cable, hob-nail, diamond, loop, drape, panel, thousand-eye, basket weave, thumb print, and other characteristic designs.

Ornamental Glass

No general collection of old American glass is complete without some of the colored and decorated ornamental glass that was produced in such quantity and variety during the latter half of the last century.

A characteristic assortment of this ornamental glass includes canes, paper weights, hens, eagle, rabbit, cat, fish, boats, and other curious dishes of milk white, black, frosted, opalescent, and bright colors.

BUFFALO POTTERY TRIP

Visitors will see the manufacture of vitrified china as used in clubs, hotels, steamships, railroads, restaurants, etc.

Guides will show raw materials, method of mixing equipment, lawning of slip and pumping into presses, pugging of clay, and the making of casting slip.

In the clay shop will be seen the making of ware such as plates, saucers, etc., on a round jigger and platters on the oval jigger, turning of cups, handling of cups, casting of jugs, creams, etc. Of special interest in the clay shop is the manufacture of Lamelle ware where the center of the item is in one color and the rim in a different color giving a perfect contrast. A variety of colored bodies will be seen in production. The first continuous drying machine installed in a pottery will be seen in operation.

The firing, lining, printing, and application of decalcomania will be explained, all for underglaze decorating, followed by the dipping and glost firing.

In the printing shop will be seen the second rotary printing press installed in the United States. The continuous electric glost kiln will not be in operation, but trucks will be loaded and an explanation covering complete operation will be given.

The trip will take approximately one and one-half hours.—F. HAZELWOOD

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February 15, 1935

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Gentlemen:

Once a year during the past, the annual convention of the American Ceramic Society has afforded us the opportunity of meeting our friends to renew acquaintances as well as to exchange helpful ideas.

It seems to us that this year, when we are placed at the necessity of lowering costs and selling a greatly improved quality of merchandise at lower prices, it is more necessary than ever that we attend the convention at Buffalo and absorb as many helpful ideas as possible.

We have many new things of interest, outstanding of which is our CAST SAGGER. You have probably heard considerably general talk about this product, which is being manufactured in our new plant at Newell, W. Va., and we would like to have you drop around to see us and get specific information and look at samples.

We wish to thank our many friends for the confidence placed in us during the past and to assure them that we will give our best attention to any problems that may be presented to us in the future.

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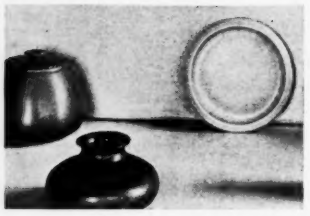

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The Vitro Mfg. Co.

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Ammonium Carbonate
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The Vitro Mfg. Co.

Antimony Oxide
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B

Ball Mills
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McDanel Refractory Porcelain Co.

Ball Mills (Laboratory Type)
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The Hommel Co., O., Inc.

Barium Carbonate
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Norton Co. (*Alundum Crystolon*)

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Blocks (Refractory)
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Boric Acid (Anhydrous)
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The Vitro Mfg. Co.

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Norton Co.

C

Carbofrax (Refractory Products)
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Carbolon (Refractory Products)
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Carbonates (Barium, Lead)
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Clay (Potters)
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Clay (Sagger)
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Clay (Wad)
Potters Supply Co.
Spinks Clay Co., H. C.

Clay (Wall Tile)
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Paper Makers Importing Co.
Spinks Clay Co., H. C.

Clocks (Gauge Board)
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D

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The Roessler & Hasslacher Chemical Co.
The Vitro Mfg. Co.

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E

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Ferro Enamel Corp.
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Porcelain Enamel & Mfg. Co.

Enameling Furnaces
Carborundum Co. (*Carboradiant*)
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Porcelain Enamel & Mfg. Co.

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Enameling Muffles
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Metal & Thermit Corp.
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The Vitro Mfg. Co.

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Ferro Enamel Corp.
The Hommel Co., O., Inc.
Porcelain Enamel & Mfg. Co.

Exolon (Refractory Products)
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F

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The Vitro Mfg. Co.

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Norton Co.

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The Vitro Mfg. Co.

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Porcelain Enamel & Mfg. Co.

G

Glaze and Body Spar
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Ferro Enamel Corp.
The Hommel Co., O., Inc.
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Titanium Alloy Mfg. Co.
The Vitro Mfg. Co.

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Paper Makers Importing Co.
The Roessler & Hasslacher Chemical Co.
The Vitro Mfg. Co.

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The Hommel Co., O., Inc.
The Roessler & Hasslacher Chemical Co.
The Vitro Mfg. Co.

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H

Hearths
Carborundum Co.
(*Carbofrax* heat treating)
Norton Co. (*Crystolon*)

Hearths (High Aluminous Clay, Electrically Sintered Aluminum Oxide, Silicon Carbide)
Carborundum Co.
Norton Co.

I

Iron (Enameling)
American Rolling Mill Co.

Iron Oxide
Drakenfeld & Co., B. F.

K

Kaolin
Ceramic Color & Chemical Mfg. Co.
Edgar Brothers Co.
Hammill & Gillespie, Inc.
The Hommel Co., O., Inc.
Paper Makers Importing Co.
The Roessler & Hasslacher Chemical Co.
The Vitro Mfg. Co.

Kilns China, (Decorating)
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Kryolith
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Jungmann & Co.
The Roessler & Hasslacher Chemical Co.
The Vitro Mfg. Co.

L

Leeds (High Aluminous Clay, Electrically Sintered Aluminum Oxide, Silicon Carbide)
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Carborundum Co.
Norton Co.

M

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Norton Co.

Magnesite
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Hammill & Gillespie, Inc.
The Hommel Co., O., Inc.
The Roessler & Hasslacher Chemical Co.
The Vitro Mfg. Co.

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Drakenfeld & Co., B. F.
Hammill & Gillespie, Inc.
The Hommel Co., O., Inc.
The Roessler & Hasslacher Chemical Co.
The Vitro Mfg. Co.

Metals (Porcelain Enameling)
American Rolling Mill Co.

Minerals
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Drakenfeld & Co., B. F.
The Hommel Co., O., Inc.
The Roessler & Hasslacher Chemical Co.
The Vitro Mfg. Co.

Muffles (Furnace)
Carborundum Co. (*Carbofrax*)
Chicago Vitreous Enamel Product Co.
Ferro Enamel Corp.
Norton Co.

Mullite (Artificial)
The Exolon Co.

Muriatic Acid
The Hommel Co., O., Inc.

N

Nitrates (Cobalt, Sodium)
Ceramic Color & Chemical Mfg. Co.
The Hommel Co., O., Inc.
The Roessler & Hasslacher Chemical Co.
The Vitro Mfg. Co.

O

Opacifiers
Ceramic Color & Chemical Mfg. Co.
The Hommel Co., O., Inc.
Jungmann & Co.
Metal & Thermit Corp
Porcelain Enamel & Mfg. Co.
The Roessler & Hasslacher Chemical Co.
Titanium Alloy Mfg. Co.
The Vitro Mfg. Co.

Oxides
Ceramic Color & Chemical Mfg. Co.
Chicago Vitreous Enamel Product Co.
Drakenfeld & Co., B. F.
Ferro Enamel Corp.
The Hommel Co., O., Inc.
Metal & Thermit Corp.
Porcelain Enamel & Mfg. Co.
The Roessler & Hasslacher Chemical Co.
Titanium Alloy Mfg. Co.
The Vitro Mfg. Co.

P

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Potters Supply Co

Porcelain Enameling Service (Practical)
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Ferro Enamel Corp.
The Hommel Co., O., Inc.
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Porcelain Enamel & Mfg. Co.
Titanium Alloy Mfg. Co.
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Ferro Enamel Corp.
The Hommel Co., O., Inc.
Porcelain Enamel & Mfg. Co.
Titanium Alloy Mfg. Co.
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Potash (Carbonate)
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The Hommel Co., O., Inc.
Jungmann & Co.
The Roessler & Hasslacher Chemical Co.
The Vitro Mfg. Co.

Pyrometer Tubes (Refractory and Hard Porcelain)
McDanel Refractory Porcelain Co.

R

Refractories
Carborundum Co.
The Exolon Co.
Norton Co.

Refractory Materials
Carborundum Co.
The Exolon Co.
Norton Co.
Titanium Alloy Mfg. Co.

Rutile
Ceramic Color & Chemical Mfg. Co.
Drakenfeld & Co., B. F.
The Hommel Co., O., Inc.
Metal & Thermit Corp.
The Roessler & Hasslacher Chemical Co.
Titanium Alloy Mfg. Co.
The Vitro Mfg. Co.

S

Saggers
Carborundum Co.
Norton Co.
Potters Supply Co.

Selenite of Sodium
Drakenfeld & Co., B. F.
The Hommel Co., O., Inc.
The Vitro Mfg. Co.

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W

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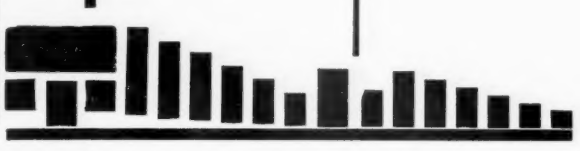

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Cerium Hydrate
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Clay, Vallendar
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Copper Oxides
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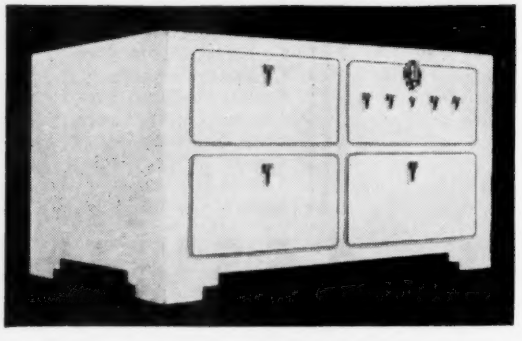

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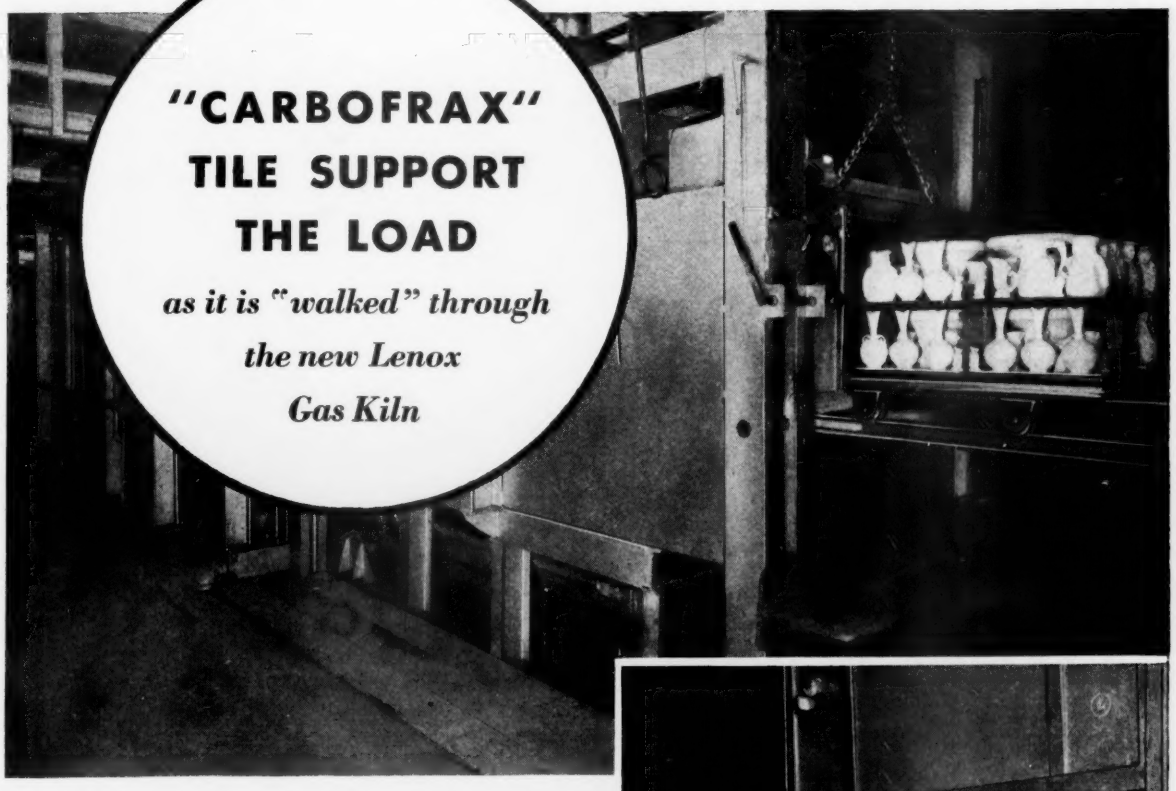

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Jan. 11, 1935

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Specialists in Opacifiers

FOR many years, the Metal & Thermit Corporation has held a prominent place in the ceramic industry. Hundreds of firms, including many of the largest plants in the country, use M & T Tin Oxide and M & T Sodium Antimonate, exclusively. More than that, these same firms call frequently on the Ceramic Department of the Metal & Thermit Corporation for help in solving technical problems.

Extensive research and continuous development by the company have created a vast fund of practical knowledge and experience to draw upon in meeting the many problems which arise, not only in the manufacture, but, equally important, in the application of its products. M & T technicians and representatives, long familiar with every phase of such work, have become veritable "specialists in opacifiers."

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